www.mtg.in | April 2018 | Pages 92 | ₹ 30

PRACTICE PAPERS

JEE MAIN ADVANCED | BITSAT | NEET | AIIMS

CHEMISTRY today

Exam Special

India's #1
CHEMISTRY MONTHLY FOR
JEE (Main & Advanced) & NEET

CHEMISTRY MUSING

CBSE BOARD
Solved Paper

CONCEPT MAP

PUZZLE CORNER

mtG
Trust of more than
1 Crore Readers
Since 1982

2018100010641

7 MOST FREQUENTLY ASKED TOPICS IN NEET

ONCE AGAIN ALLEN

in LIMCA BOOK of RECORDS

Limca
Book of Records

National Record

The top 10 all-India positions in the MBBS Entrance Examination for the All-India Institute of Medical Sciences (AIIMS) 2017 were all attained by students of a single coaching institute – the **ALLEN Career Institute** – in Kota, Rajasthan. Seven of these students were from the Classroom Programme and three from the Distance Learning Programme.

Vatsala Kaul Banerjee
Editor, *Limca Book of Records*

Date of Issue: December 2017
(LBR 2018)

"LIMCA BOOK OF RECORDS" IS THE COPYRIGHT OF THE COCA-COLA COMPANY. "LIMCA" IS THE REGISTERED TRADEMARK OF THE COCA-COLA COMPANY. THIS CERTIFICATE DOES NOT NECESSARILY DENOTE AN ENTRY INTO *LIMCA BOOK OF RECORDS*.

AIR 1

NISHITA PUROHIT
Classroom

AIR 2

ARCHIT GUPTA
Classroom

AIR 3

TAMOGHNA GHOSH
Distance

AIR 4

NIPUN CHANDRA
Distance

AIR 5

HARSH AGARWAL
Classroom

AIR 6

RISHAV RAJ
Classroom

AIR 7

HARSHIT ANAND
Classroom

AIR 8

RINKU SARMAH
Distance

AIR 9

ABHISHEK DOGRA
Classroom

AIR 10

MANISH MULCHANDANI
Classroom

ALLEN STUDENTS SECURED TOP 10 ALL INDIA RANKS IN AIIMS 2017
LIMCA BOOK OF RECORDS RECOGNISES IT AS A NATIONAL RECORD

ALLEN CAREER INSTITUTE
path to success
KOTA (RAJASTHAN)
www.allen.ac.in

Corporate Office:
"SANKALP", CP-6, Indra Vihar,
Kota (Raj.), India, 324005
0744-2757575 info@allen.ac.in

ADMISSION OPEN (Session 2018-19)
IIT-JEE (Advanced) & JEE (Main) | NEET (UG) / AIIMS
Class 6th to 10th (NTSE, Olympiads & Boards)
To Apply online (₹500), Log on to **www.allen.ac.in** or walk-in to nearest ALLEN Center for Application Form (₹ 700).

A Great Victory in Medical History

VISWASAI

Leading the way with over 400 MEDICAL SEATS 2012 - 17 *so far*

Stress Free Education Makes A Student Successful

AIIMS ALL INDIA RANK

4 (OBC) th RANK

35 th RANK

K.YESHWANTH H.T.NO.1510000349

JIPMER ALL INDIA RANK

46 th RANK

M.RISHITHA H.T.NO.35010460

Honourable Chief Minister of Andhra Pradesh, Sri Nara Chandra Babu naidu garu
presenting shield to VISWASAI'S Medical Rankers.

JEE(IIT& NIT'S)

IIT BHU VARANASI — G.PRAVEEN KUMAR

IIT BHU VARANASI — P.MURALI KRISHNA

IIT TIRUPATI — P.GANGADHAR TEJA

BITS HYD — HITESH ARAVIND

IISER TIRUVANANTHAPURAM — M.AKHIKLESH

NIT CALICUT — K.SAI KRISHNA TEJA

NIT WARANGAL — P.HARICHANDANA

NIT CALICUT — P.V.BINDHU BARGAVI

NIT CALICUT — K.SAI HEMANTH

NIT SURAT — A.SREE HARSHA

NIT RAYAPUR — A.ASRITHA

NIT NAGPUR — T.V.R.AKHIL

IIIT JABALPUR — G.SREEKAR

NDA PUNE — A.GOURAV

NIT TPG — N.SAI SRIKAR

NIT TPG — T.NAVEEN

NIT RURKELA — M.D.ASRAF

NIT PUDICHERRY — M.D.ASRAF

NIT TPG — K.SIRISHA

Dr.N.Satyanarayana & G.Krishna Mohan's
VISWASAI IIT ACADEMY
NELLORE & TIRUPATI

Hostel facility is available

Dr.N.Satyanarayana & G.Krishna Mohan's
VISWASAI MEDICAL ACADEMY
NELLORE & TIRUPATI

Magunta Lay out NELLORE.Ph:8886770470,9703745222,9160670002,03

Bairagipatteda TIRUPATI.Ph:9160670004,8886667012,13,14. www.viswasai.com

CHEMISTRY today

Volume 27 No. 4 April 2018

Managing Editor
Mahabir Singh

Editor
Anil Ahlawat

Corporate Office:
Plot 99, Sector 44 Institutional area, Gurgaon -122 003 (HR).
Tel : 0124-6601200 e-mail : info@mtg.in website : www.mtg.in

Regd. Office:
406, Taj Apartment, Near Safdarjung Hospital, New Delhi - 110029.

CONTENTS

TO OUR READERS

We are happy that intelligent students, teachers and other professionals continue to patronise Mathematics Today, Chemistry Today, Physics For You and Biology Today.

To them, we are addressing this open letter in view of increase in the cost of production and postage in the last seven years. All round spiralling prices have pushed production costs so high, that many in out fraternity find it impossible to continue business. We are compelled to raise the price to ₹ 40 from July 2018 issue.

We understand the pressure of cost on the student-teacher community in general but, we are hoping our readers will understand our problems and that we have no option but to comply with this unavoidable move.

We on our part, will keep up our efforts to improve the magazines in all its aspects.

Printed and Published by Mahabir Singh on behalf of MTG Learning Media Pvt. Ltd. Printed at HT Media Ltd., B-2, Sector-63, Noida, UP-201307 and published at 406, Taj Apartment, Ring Road, Near Safdarjung Hospital, New Delhi - 110029.
Editor : Anil Ahlawat

CHEMISTRY MUSING

PROBLEM SET 57

Chemistry Musing was started from August '13 issue of Chemistry Today. The aim of Chemistry Musing is to augment the chances of bright students preparing for JEE (Main and Advanced) / NEET / AIIMS / JIPMER with additional study material. In every issue of Chemistry Today, 10 challenging problems are proposed in various topics of JEE (Main and Advanced) / NEET. The detailed solutions of these problems will be published in next issue of Chemistry Today.

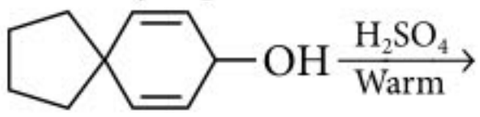
The readers who have solved five or more problems may send their solutions. The names of those who send atleast five correct solutions will be published in the next issue. We hope that our readers will enrich their problem solving skills through "Chemistry Musing" and stand in better stead while facing the competitive exams.

JEE MAIN/NEET

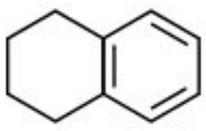
1. A slice of banana weighing 2.502 g was burnt in a bomb calorimeter producing a temperature rise of 3.05 °C. The combustion of 0.316 g of benzoic acid in the same calorimeter produced a temperature rise of 3.24 °C. The heat of combustion of benzoic acid at constant volume is –3227 kJ mol^{-1}. If average banana weighs 125 g, how many kilocalories can be obtained from one average banana?

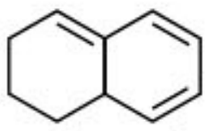
(a) 393.18 (b) 93.97 (c) 70.87 (d) 189.57

2. The major product formed in the following reaction

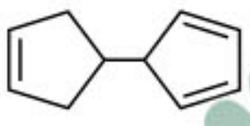


is

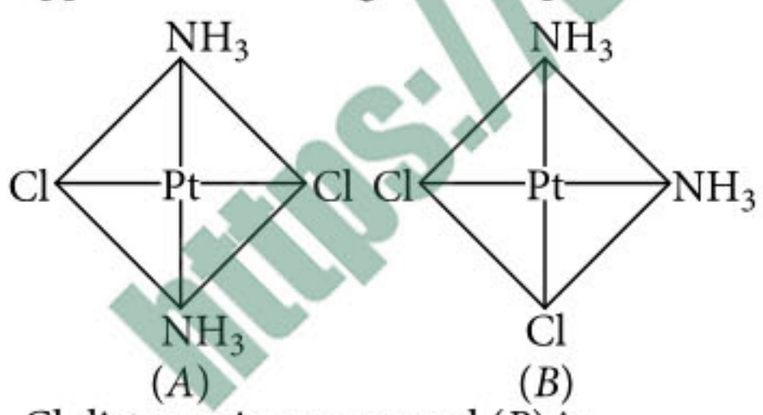
(a) 

(b) 

(c) 

(d) 

3. The platinum-chlorine distance has been found to be 2.32 Å in several crystalline compounds. This value applies to both the given compounds *A* and *B* :

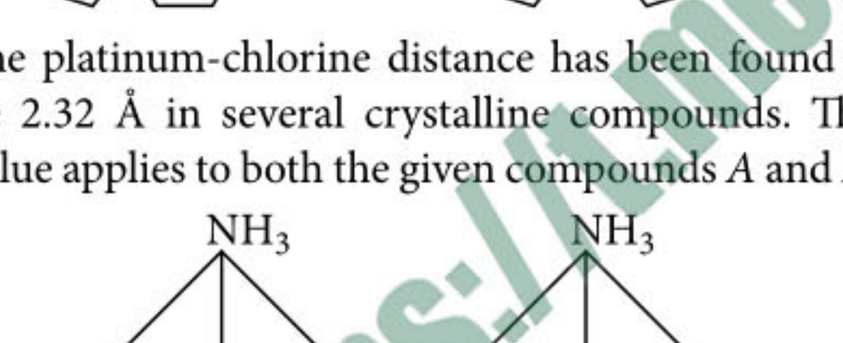


Cl — Cl distance in compound (*B*) is

(a) 2.32 Å (b) 1.52 Å

(c) 2.15 Å (d) 3.28 Å

4. Consider the following sequence of reactions :

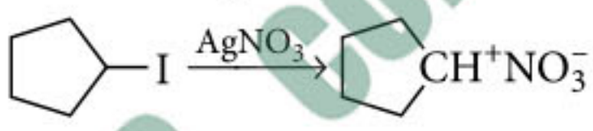


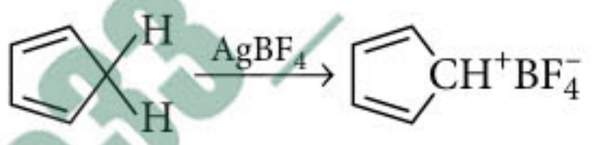
In the above sequence of reactions, *Y* and *A* are respectively

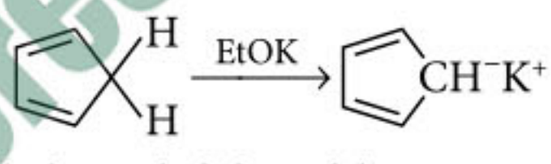
(a) H_3PO_2 and H_3PO_4 (b) H_3PO_4 and $H_4P_2O_7$

(c) H_3PO_4 and HPO_3 (d) H_3PO_3 and H_3PO_4

5. For the following reactions

I. 

II. 

III. 

rank the probability of their occurrence (fastest first).

(a) I > II > III (b) III > II > I

(c) II > III > I (d) III > I > II

JEE ADVANCED

6. When cells of skeletal vacuoles of a frog were placed in a series of NaCl solutions of different concentrations at 25 °C, it was observed microscopically that they remained unchanged in 0.7% solution, shrank in more concentrated and swelled in more dilute solutions. Water in 0.7% salt solution freezes at –0.406 °C. What is the osmotic pressure of the cell cytoplasm at 25 °C?

(K_f for water = 1.86 K kg mol^{-1})

(a) 5.29 g atm (b) 13.23 atm

(c) 1.5 atm (d) None

Solution Senders of Chemistry Musing

Set - 56

- Venugopal Reddy, Andhra Pradesh

Set - 55

- Aruna Yadav, Haryana
- Chetan Kumar, Karnataka

COMPREHENSION

20 mL of M/60 $KBrO_3$ was reacted with a sample of SeO_3^{2-}. The Br_2 thus evolved was removed and the excess of $KBrO_3$ was titrated with 5 mL of M/60 solution of $NaAsO_2$. The reactions involved are

$$SeO_3^{2-} + BrO_3^- + H^+ \longrightarrow SeO_4^{2-} + Br_2 + H_2O \quad ...(i)$$

$$BrO_3^- + AsO_2^- + H_2O \longrightarrow Br^- + AsO_4^{3-} + H^+ \quad ...(ii)$$

[M.wt. of SeO_3^{2-} = 127 g mol^{-1}]

7. Excess meq of BrO_3^- in reaction (ii) is

(a) $\frac{1}{6}$ (b) $\frac{11}{6}$

(c) $\frac{1}{36}$ (d) $\frac{11}{36}$

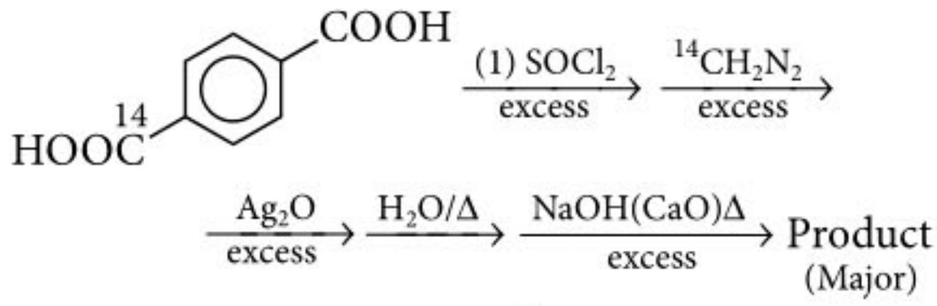
8. Amount of SeO_3^{2-} in mg is

(a) 19.4 mg (b) 194 mg

(c) 970 mg (d) 97 mg

INTEGER VALUE

9. Observe the given sequence of reactions carefully,



Now, find the number of C^{14} atoms present in the major product.

10. In the determination of hardness of a sample of water, the following results were obtained :

Volume of sample of H_2O = 100 mL

Volume of N/50 Na_2CO_3 added to it = 20 mL

Volume of N/50 H_2SO_4 used to back titrate the unreacted Na_2CO_3 = 10 mL

The hardness of water in g L^{-1} is $x \times 10^{-1}$. The value of x is

◈◈

07

Most frequently asked topics in NEET

- Quantum Mechanical Model of Atom
- Acids, Bases and their Ionization
- Alkanes, Alkenes and Alkynes
- Aromatic Hydrocarbons
- Nernst Equation, Electrolytic Cells and Electrolysis
- Lanthanoids and Some Important Compounds of Transition Elements
- Bonding in Coordination Compounds

Questions from last 5 years (2017-2013) are covered here to give you an idea to score high in exam.

Quantum Mechanical Model of Atom

1. Which one is the wrong statement?

(a) The uncertainty principle is $\Delta E \times \Delta t \geq \frac{h}{4\pi}$.

(b) Half filled and fully filled orbitals have greater stability due to greater exchange energy, greater symmetry and more balanced arrangement.

(c) The energy of 2*s*-orbital is less than the energy of 2*p*-orbital in case of hydrogen like atoms.

(d) de-Broglie's wavelength is given by $\lambda = \frac{h}{mv}$, where, m = mass of the particle, v = group velocity of the partice. *(2017)*

2. How many electrons can fit in the orbital for which $n = 3$ and $l = 1$?

(a) 2 (b) 6 (c) 10 (d) 14 *(2016)*

3. Which of the following pairs of *d*-orbitals will have electron density along the axes?

(a) d_{z^2}, d_{xz} (b) d_{xz}, d_{yz}

(c) $d_{z^2}, d_{x^2-y^2}$ (d) $d_{xy}, d_{x^2-y^2}$ *(2016)*

4. Two electrons occupying the same orbital are distinguished by

(a) azimuthal quantum number

(b) spin quantum number

(c) principal quantum number

(d) magnetic quantum number. *(2016)*

5. Which is the correct order of increasing energy of the listed orbitals in the atom of titanium?
[At. no. (Z) = 22]

(a) 4*s* 3*s* 3*p* 3*d* (b) 3*s* 3*p* 3*d* 4*s*

(c) 3*s* 3*p* 4*s* 3*d* (d) 3*s* 4*s* 3*p* 3*d* *(2015)*

6. What is the maximum number of orbitals that can be identified with the following quantum numbers?
$n = 3, l = 1, m_l = 0$

(a) 1 (b) 2 (c) 3 (d) 4 *(2014)*

7. What is the maximum number of electrons that can be associated with the following set of quantum numbers?
$n = 3, l = 1$ and $m = -1$

(a) 4 (b) 2 (c) 10 (d) 6 *(2013)*

Acids, Bases and their Ionization

8. Which of the following fluoro-compounds is most likely to behave as a Lewis base?

(a) BF_3 (b) PF_3 (c) CF_4 (d) SiF_4 *(2016)*

9. The percentage of pyridine (C_5H_5N) that forms pyridinium ion ($C_5H_5\overset{+}{N}H$) in a 0.10 M aqueous pyridine solution (K_b for $C_5H_5N = 1.7 \times 10^{-9}$) is

(a) 0.0060% (b) 0.013%

(c) 0.77% (d) 1.6% *(2016)*

10. Aqueous solution of which of the following compounds is the best conductor of electric current?
(a) Hydrochloric acid, HCl
(b) Ammonia, NH_3 (c) Fructose, $C_6H_{12}O_6$
(d) Acetic acid, $C_2H_4O_2$ *(2015)*

11. What is the pH of the resulting solution when equal volumes of 0.1 M NaOH and 0.01 M HCl are mixed?
(a) 2.0 (b) 7.0 (c) 1.04 (d) 12.65
(2015)

12. Which of the following salts will give highest pH in water?
(a) KCl (b) NaCl (c) Na_2CO_3 (d) $CuSO_4$
(2014)

13. Which of these is least likely to act as a Lewis base?
(a) BF_3 (b) PF_3 (c) CO (d) F^- *(2013)*

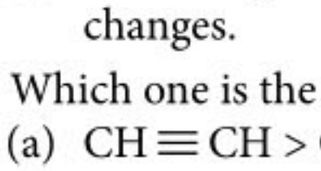
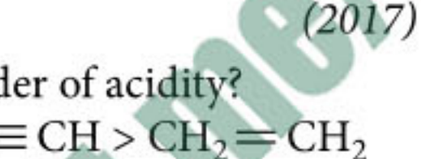
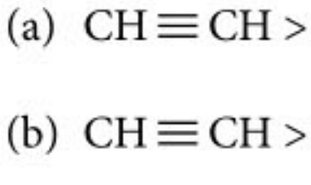
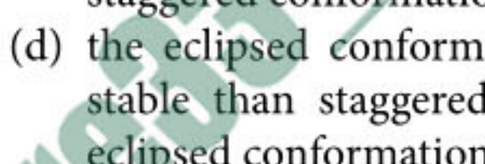
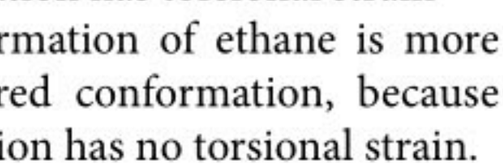
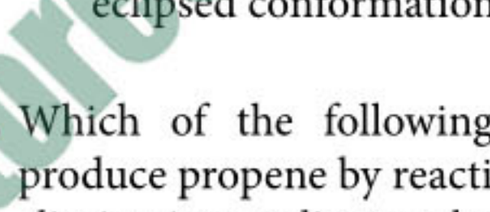
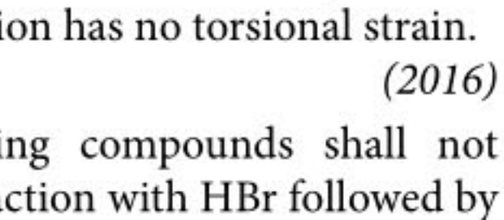
Alkanes, Alkenes and Alkynes

14. With respect to the conformers of ethane, which of the following statements is true?
(a) Bond angle changes but bond length remains same.
(b) Both bond angle and bond length change.
(c) Both bond angle and bond length remain same.
(d) Bond angle remains same but bond length changes. *(2017)*

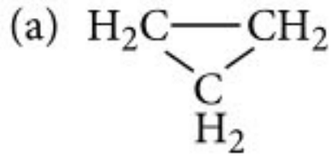
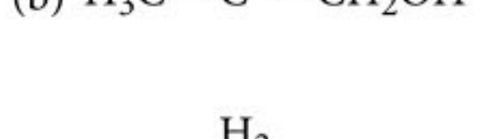
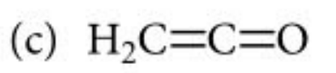
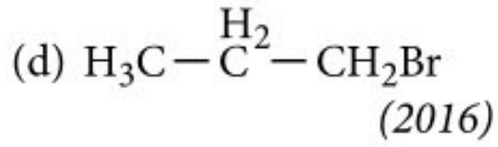
15. Which one is the correct order of acidity?
(a) $CH \equiv CH > CH_3 - C \equiv CH > CH_2 = CH_2 > CH_3 - CH_3$
(b) $CH \equiv CH > CH_2 = CH_2 > CH_3 - C \equiv CH > CH_3 - CH_3$
(c) $CH_3 - CH_3 > CH_2 = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$
(d) $CH_2 = CH_2 > CH_3 - CH = CH_2 > CH_3 - C \equiv CH > CH \equiv CH$
(2017)

16. Predict the correct intermediate and product in the following reaction :

$$H_3C - C \equiv CH \xrightarrow[HgSO_4]{H_2O,\ H_2SO_4} \underset{(A)}{\text{Intermediate}} \longrightarrow \underset{(B)}{\text{Product}}$$

(a) A :  B : 
(b) A :  B : 
(c) A :  B : 
(d) A :  B : 
(2017)

17. The correct statement regarding the comparison of staggered and eclipsed conformations of ethane, is
(a) the eclipsed conformation of ethane is more stable than staggered conformation even though the eclipsed conformation has torsional strain
(b) the staggered conformation of ethane is more stable than eclipsed conformation, because staggered conformation has no torsional strain
(c) the staggered conformation of ethane is less stable than eclipsed conformation, because staggered conformation has torsional strain
(d) the eclipsed conformation of ethane is more stable than staggered conformation, because eclipsed conformation has no torsional strain.
(2016)

18. Which of the following compounds shall not produce propene by reaction with HBr followed by elimination or direct only elimination reaction?
(a)  (b) 
(c)  (d) 
(2016)

19. The compound that will react most readily with gaseous bromine has the formula
(a) C_3H_6 (b) C_2H_2 (c) C_4H_{10} (d) C_2H_4
(2016)

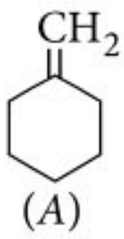
20. The pair of electrons in the given carbanion, $CH_3C \equiv C^-$ is present in which of the following orbitals?
(a) sp^2 (b) sp (c) $2p$ (d) sp^3
(2016)

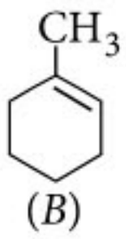
21. In the reaction,

$$H - C \equiv CH \xrightarrow[(ii)\ CH_3CH_2Br]{(i)\ NaNH_2/liq.\ NH_3} X \xrightarrow[(ii)\ CH_3CH_2Br]{(i)\ NaNH_2/liq.\ NH_3} Y$$

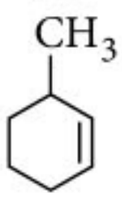
X and Y are
(a) X = 2-butyne, Y = 2-hexyne
(b) X = 1-butyne, Y = 2-hexyne
(c) X = 1-butyne, Y = 3-hexyne
(d) X = 2-butyne, Y = 3-hexyne. *(2016)*

22. In the reaction with HCl, an alkene reacts in accordance with the Markovnikov's rule to give a product 1-chloro-1-methylcyclohexane. The possible alkene is

(a)  (*A*)

(b)  (*B*)

(c) (*A*) and (*B*)

(d) 

(2015)

23. 2,3-Dimethyl-2-butene can be prepared by heating which of the following compounds with a strong acid?

(a) $(CH_3)_3CCH{=}CH_2$

(b) $(CH_3)_2C{=}CHCH_2CH_3$

(c) $(CH_3)_2CHCH_2CH{=}CH_2$

(d) $(CH_3)_2CH-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH{=}CH_2$ *(2015)*

24. Identify *Z* in the sequence of reactions :

$$CH_3CH_2CH{=}CH_2 \xrightarrow{HBr/H_2O_2} Y \xrightarrow{C_2H_5ONa} Z$$

(a) $CH_3(CH_2)_3OCH_2CH_3$

(b) $(CH_3)_2CHOCH_2CH_3$

(c) $CH_3(CH_2)_4OCH_3$

(d) $CH_3CH_2CH(CH_3)OCH_2CH_3$ *(2014)*

25. Which of the following organic compounds has same hybridization as its combustion product (CO_2)?

(a) Ethane (b) Ethyne

(c) Ethene (d) Ethanol *(2014)*

Aromatic Hydrocarbons

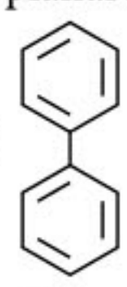
26. Which of the following can be used as the halide component for Friedel-Crafts reaction?

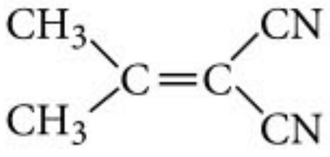
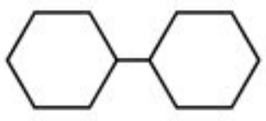
(a) Chlorobenzene (b) Bromobenzene

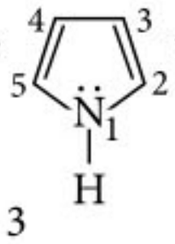
(c) Chloroethene (d) Isopropyl chloride

(2016)

27. In which of the following molecules, all atoms are co-planar?

(a)  (b) 

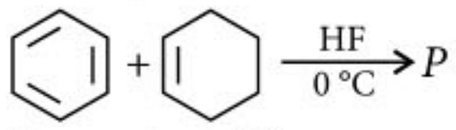
(c)  (d)  *(2016)*

28. In pyrrole  the electron density is maximum on

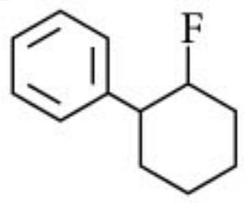
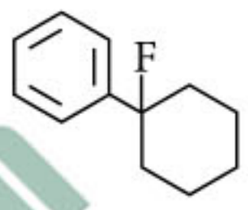
(a) 2 and 3 (b) 3 and 4

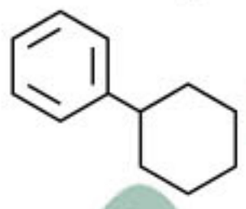
(c) 2 and 4 (d) 2 and 5 *(2016)*

29. In the given reaction,



the product *P* is

(a)  (b) 

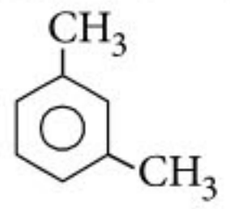
(c)  (d)  *(2016)*

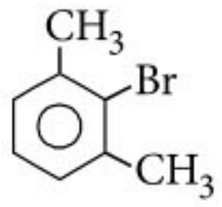
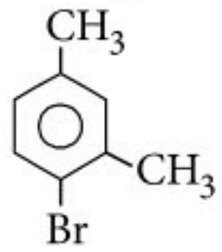
30. Consider the nitration of benzene using mixed conc. H_2SO_4 and HNO_3. If a large amount of $KHSO_4$ is added to the mixture, the rate of nitration will be

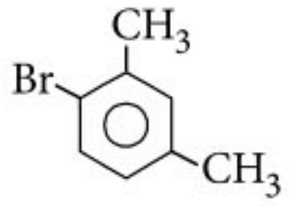
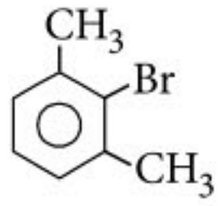
(a) unchanged (b) doubled

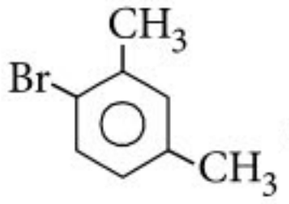
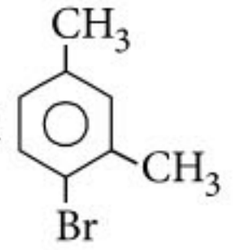
(c) faster (d) slower. *(2016)*

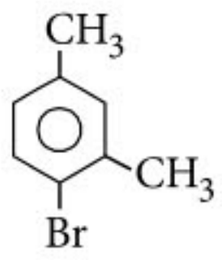
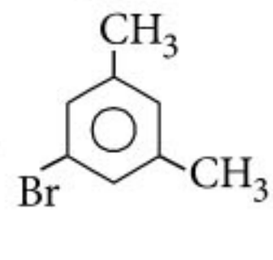
31. What products are formed when the following compound is treated with Br_2 in the presence of $FeBr_3$?

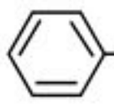


(a)  and 

(b)  and 

(c)  and 

(d)  and  *(2014)*

32. The radical,  is aromatic because it has

(a) 7 *p*-orbitals and 7 unpaired electrons
(b) 6 *p*-orbitals and 7 unpaired electrons
(c) 6 *p*-orbitals and 6 unpaired electrons
(d) 7 *p*-orbitals and 6 unpaired electrons. *(2013)*

33. Some *meta*-directing substituents in aromatic substitution are given. Which one is most deactivating?

(a) —COOH (b) $-NO_2$
(c) $-C \equiv N$ (d) $-SO_3H$ *(2013)*

34. Which of the following compounds will not undergo Friedal-Crafts reaction easily?

(a) Nitrobenzene (b) Toluene
(c) Cumene (d) Xylene *(2013)*

Nernst Equation, Electrolytic Cells and Electrolysis

35. In the electrochemical cell :

$Zn|ZnSO_4(0.01\ M)||CuSO_4(1.0\ M)|Cu$, the emf of this Daniell cell is E_1. When the concentration of $ZnSO_4$ is changed to 1.0 M and that of $CuSO_4$ changed to 0.01 M, the emf changes to E_2. From the following, which one is the relationship between E_1 and E_2? (Given, $RT/F = 0.059$)

(a) $E_1 < E_2$ (b) $E_1 > E_2$
(c) $E_2 = 0 \neq E_1$ (d) $E_1 = E_2$ *(2017)*

36. If the E°_{cell} for a given reaction has a negative value, which of the following gives the correct relationships for the values of ΔG° and K_{eq}?

(a) $\Delta G^\circ > 0; K_{eq} < 1$ (b) $\Delta G^\circ > 0; K_{eq} > 1$
(c) $\Delta G^\circ < 0; K_{eq} > 1$ (d) $\Delta G^\circ < 0; K_{eq} < 1$
(2016)

37. The pressure of H_2 required to make the potential of H_2-electrode zero in pure water at 298 K is

(a) 10^{-10} atm (b) 10^{-4} atm
(c) 10^{-14} atm (d) 10^{-12} atm *(2016)*

38. During the electrolysis of molten sodium chloride, the time required to produce 0.10 mol of chlorine gas using a current of 3 amperes is

(a) 55 minutes (b) 110 minutes
(c) 220 minutes (d) 330 minutes. *(2016)*

39. The number of electrons delivered at the cathode during electrolysis by a current of 1 ampere in 60 seconds is (charge on electron = 1.60×10^{-19} C)

(a) 6×10^{23} (b) 6×10^{20}
(c) 3.75×10^{20} (d) 7.48×10^{23} *(2016)*

40. When 0.1 mol MnO_4^{2-} is oxidised the quantity of electricity required to completely oxidise MnO_4^{2-} to MnO_4^- is

(a) 96500 C (b) 2×96500 C
(c) 9650 C (d) 96.50 C *(2014)*

41. The weight of silver (at.wt. = 108) displaced by a quantity of electricity which displaces 5600 mL of O_2 at STP will be

(a) 5.4 g (b) 10.8 g
(c) 54.0 g (d) 108.0 g *(2014)*

42. A hydrogen gas electrode is made by dipping platinum wire in a solution of HCl of pH = 10 and by passing hydrogen gas around the platinum wire at one atm pressure. The oxidation potential of electrode would be

(a) 0.118 V (b) 1.18 V
(c) 0.059 V (d) 0.59 V *(2013)*

Lanthanoids and Some Important Compounds of Transition Elements

43. Name the gas that can readily decolourise acidified $KMnO_4$ solution.

(a) SO_2 (b) NO_2 (c) P_2O_5 (d) CO_2
(2017)

44. Which one of the following statements is correct when SO_2 is passed through acidified $K_2Cr_2O_7$ solution?

(a) SO_2 is reduced.
(b) Green $Cr_2(SO_4)_3$ is formed.
(c) The solution turns blue.
(d) The solution is decolourised. *(2016)*

45. Which one of the following statements related to lanthanons is incorrect?

(a) Europium shows +2 oxidation state.
(b) The basicity decreases as the ionic radius decreases from Pr to Lu.
(c) All the lanthanons are much more reactive than aluminium.
(d) Ce(+4) solutions are widely used as oxidizing agent in volumetric analysis. *(2016)*

46. The electronic configurations of Eu (Atomic No. 63), Gd (Atomic No. 64) and Tb (Atomic No. 65) are

(a) $[Xe]4f^6 5d^1 6s^2$, $[Xe]4f^7 5d^1 6s^2$ and $[Xe]4f^8 5d^1 6s^2$
(b) $[Xe]4f^7 6s^2$, $[Xe]4f^7 5d^1 6s^2$ and $[Xe]4f^9 6s^2$
(c) $[Xe]4f^7 6s^2$, $[Xe]4f^8 6s^2$ and $[Xe]4f^8 5d^1 6s^2$
(d) $[Xe]4f^6 5d^1 6s^2$, $[Xe]4f^7 5d^1 6s^2$ and $[Xe]4f^9 6s^2$
(2016)

47. Assuming complete ionisation, same moles of which of the following compounds will require the least amount of acidified $KMnO_4$ for complete oxidation?
(a) $FeSO_3$ (b) FeC_2O_4
(c) $Fe(NO_2)_2$ (d) $FeSO_4$ *(2015)*

48. Gadolinium belongs to 4*f*-series. Its atomic number is 64. Which of the following is the correct electronic configuration of gadolinium?
(a) [Xe] $4f^9 5s^1$ (b) [Xe] $4f^7 5d^1 6s^2$
(c) [Xe] $4f^6 5d^2 6s^2$ (d) [Xe] $4f^8 6d^2$ *(2015)*

49. The reaction of aqueous $KMnO_4$ with H_2O_2 in acidic conditions gives
(a) Mn^{4+} and O_2 (b) Mn^{2+} and O_2
(c) Mn^{2+} and O_3 (d) Mn^{4+} and MnO_2 *(2014)*

50. Reason of lanthanoid contraction is
(a) negligible screening effect of *f*-orbitals
(b) increasing nuclear charge
(c) decreasing nuclear charge
(d) decreasing screening effect. *(2014)*

51. Which of the following does not give oxygen on heating?
(a) $K_2Cr_2O_7$ (b) $(NH_4)_2Cr_2O_7$
(c) $KClO_3$ (d) $Zn(ClO_3)_2$ *(2013)*

52. Which of the following lanthanoid ions is diamagnetic?
(At. nos. Ce = 58, Sm = 62, Eu = 63, Yb = 70)
(a) Eu^{2+} (b) Yb^{2+} (c) Ce^{2+} (d) Sm^{2+} *(2013)*

Bonding in Coordination Compounds

53. Correct increasing order for the wavelengths of absorption in the visible region for the complexes of Co^{3+} is
(a) $[Co(H_2O)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$
(b) $[Co(H_2O)_6]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$
(c) $[Co(NH_3)_6]^{3+}$, $[Co(en)_3]^{3+}$, $[Co(H_2O)_6]^{3+}$
(d) $[Co(en)_3]^{3+}$, $[Co(NH_3)_6]^{3+}$, $[Co(H_2O)_6]^{3+}$ *(2017)*

54. Pick out the correct statement with respect to $[Mn(CN)_6]^{3-}$.
(a) It is sp^3d^2 hybridised and tetrahedral.
(b) It is d^2sp^3 hybridised and octahedral.
(c) It is dsp^2 hybridised and square planar.
(d) It is sp^3d^2 hybridised and octahedral. *(2017)*

55. The correct increasing order of *trans*-effect of the following species is
(a) $NH_3 > CN^- > Br^- > C_6H_5^-$
(b) $CN^- > C_6H_5^- > Br^- > NH_3$
(c) $Br^- > CN^- > NH_3 > C_6H_5^-$
(d) $CN^- > Br^- > C_6H_5^- > NH_3$ *(2016)*

56. Jahn-Teller effect is not observed in high spin complexes of
(a) d^7 (b) d^8 (c) d^4 (d) d^9 *(2016)*

57. The hybridization involved in complex $[Ni(CN)_4]^{2-}$ is (At. No. Ni = 28)
(a) sp^3 (b) d^2sp^2 (c) d^2sp^3 (d) dsp^2 *(2015)*

58. Among the following complexes the one which shows zero crystal field stabilization energy (CFSE) is
(a) $[Mn(H_2O)_6]^{3+}$ (b) $[Fe(H_2O)_6]^{3+}$
(c) $[Co(H_2O)_6]^{2+}$ (d) $[Co(H_2O)_6]^{3+}$ *(2014)*

59. A magnetic moment at 1.73 B.M. will be shown by one among the following
(a) $TiCl_4$ (b) $[CoCl_6]^{4-}$
(c) $[Cu(NH_3)_4]^{2+}$ (d) $[Ni(CN)_4]^{2-}$ *(2013)*

ANSWER KEY

1. (c)	2. (a)	3. (c)	4. (b)	5. (c)
6. (a)	7. (b)	8. (b)	9. (b)	10. (a)
11. (d)	12. (c)	13. (a)	14. (c)	15. (a)
16. (c)	17. (b)	18. (c)	19. (a)	20. (b)
21. (c)	22. (c)	23. (a)	24. (a)	25. (b)
26. (d)	27. (a)	28. (d)	29. (c)	30. (d)
31. (c)	32. (c)	33. (b)	34. (a)	35. (b)
36. (a)	37. (c)	38. (b)	39. (c)	40. (c)
41. (d)	42. (d)	43. (a)	44. (b)	45. (c)
46. (b)	47. (d)	48. (b)	49. (b)	50. (a)
51. (b)	52. (b)	53. (d)	54. (b)	55. (b)
56. (b)	57. (d)	58. (b)	59. (c)	

JEE Advanced

Exam on 20th May

PRACTICE PAPER 2018

PAPER - I

SECTION 1 (MAXIMUM MARKS : 28)

- *This section contains SEVEN questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four options is (are) correct.*
- *For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

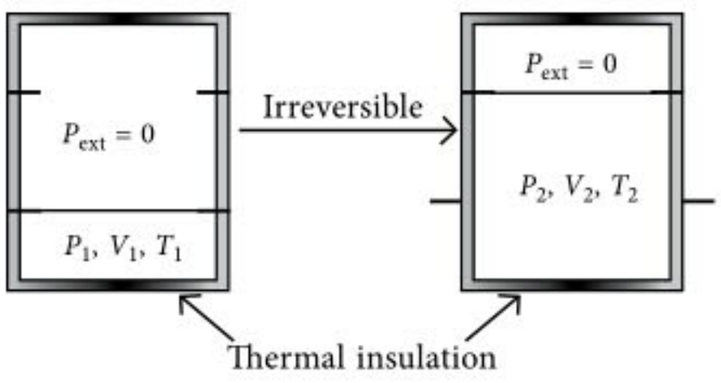
Full Marks :	+4	*If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.*
Partial Marks :	+1	*For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*
Zero Mark :	0	*If none of the bubbles is darkened.*
Negative Marks :	–2	*In all other cases.*

- *For example, if (a), (c), and (d) are all the correct options for a question, darkening all these three will get +4 marks; darkening only (a) and (d) will get +2 marks; and darkening (a) and (b) will get–2 marks, as a wrong option is also darkened.*

1. Two weak acid solutions HA_1 and HA_2, each with the same concentration and having pK_a values 3 and 5, are placed in contact with hydrogen electrode (1 atm, 25 °C) and are interconnected through a salt bridge. The emf of the cell is

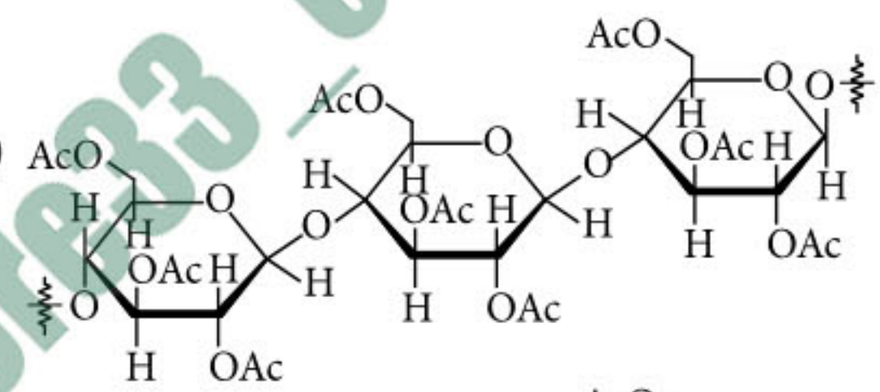
(a) 0.21 V (b) 0.059 V
(c) 0.018 V (d) 0.021 V

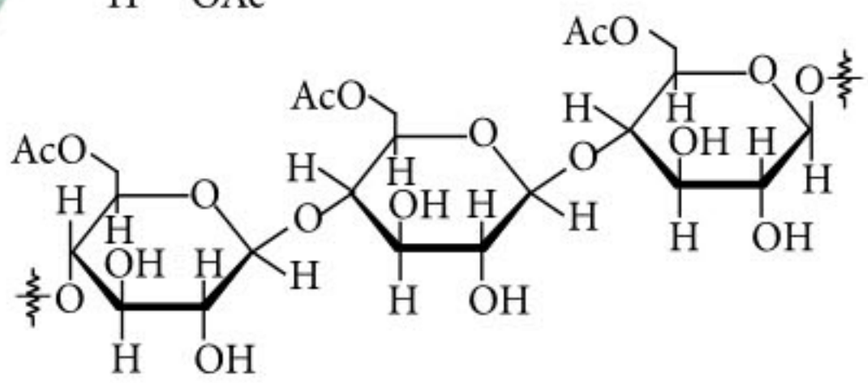
2. An ideal gas in a thermally insulated vessel at internal pressure = P_1, volume = V_1 and absolute temperature = T_1 expands irreversibly against zero external pressure, as shown in the diagram. The final internal pressure, volume and absolute temperature of gas are P_2, V_2 and T_2, respectively. For this expansion,

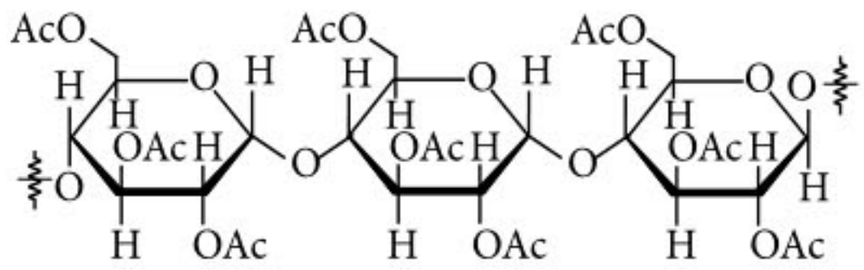


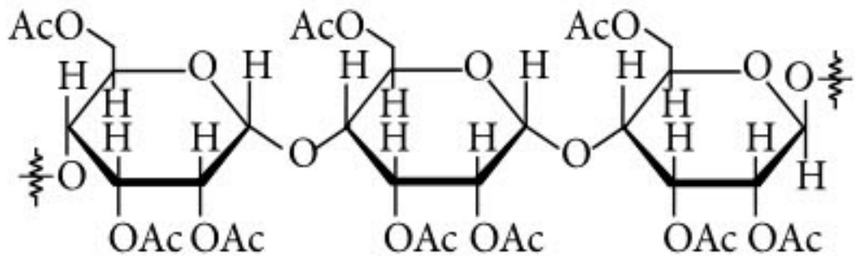
(a) $q = 0$ (b) $T_2 = T_1$
(c) $P_2V_2 = P_1V_1$ (d) $P_2V_2^{\gamma} = P_1V_1^{\gamma}$

3. Cellulose upon acetylation with excess acetic anhydride/H_2SO_4(catalytic) gives cellulose triacetate whose structure is

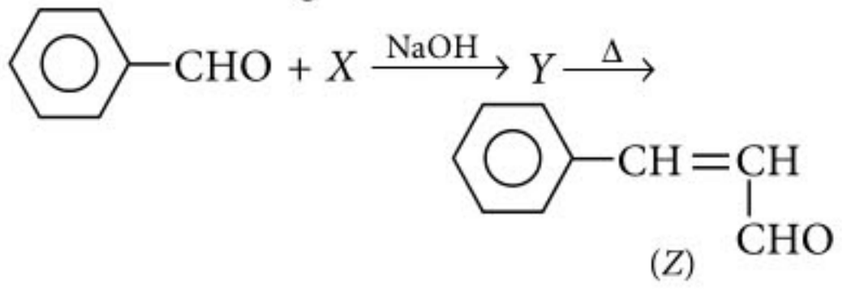
(a)


(b)


(c)


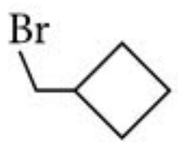
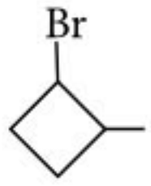
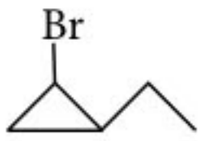
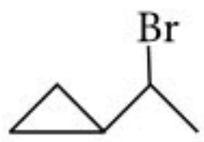
(d)


4. Which of the following statement(s) is/are correct for the reaction given below?

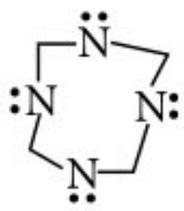


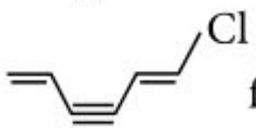
(a) It is an example of aldol condensation.
(b) X = HCHO, Y = Acetal
(c) $X = CH_3CHO$,
Y = 3-Hydroxy-3-phenyl propanaldehyde
(d) It is Claisen-Schmidt condensation.

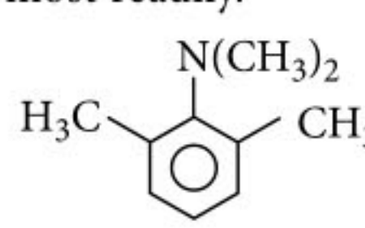
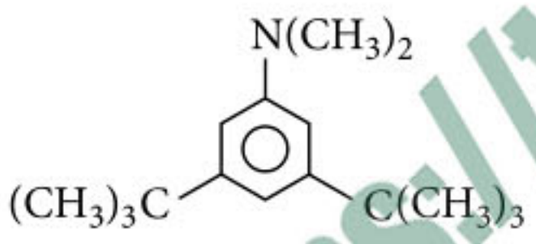
5. Compound X,(C_5H_9Br) does not add Br_2/CCl_4. On treatment with alcoholic KOH gives $Y(C_5H_8)$, which adds to Br_2/CCl_4. (Y) on ozonolysis gives Z, ($C_5H_8O_2$). (X) could be

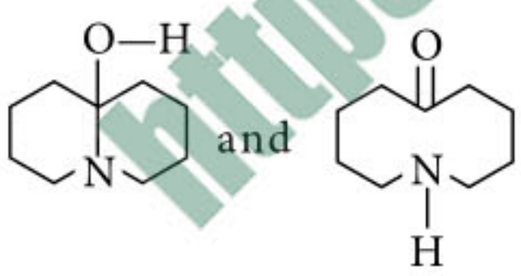
(a) 
(b) 
(c) 
(d) 

6. Which of the following statements are incorrect?

(a)  is more basic than $(CH_3)_3N$:.

(b)  forms white precipitate with $Ag^+_{(aq)}$ most readily.

(c)  is more basic than 

(d)  are resonating structures to each other.

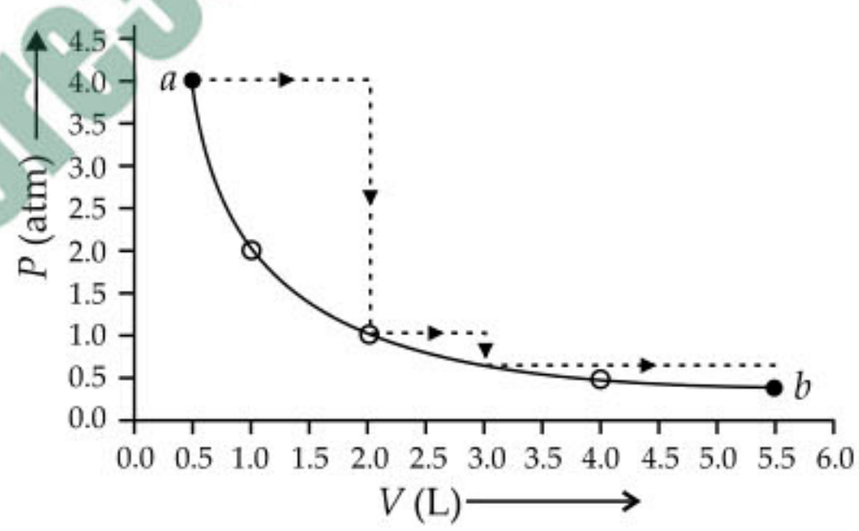
7. 4, 4′-Dinitrodiphenyl is obtained when
(a) 4-nitrochlorobenzene is heated with Na/ether
(b) 4-nitroiodobenzene is heated with copper powder in a sealed tube
(c) diphenyl is heated with a mixture of conc. HNO_3 + conc. H_2SO_4
(d) nitrobenzene is treated with 4-nitro-chlorobenzene in presence of anhyd. $AlCl_3$.

SECTION 2 (MAXIMUM MARKS : 15)

- *This section contains FIVE questions.*
- *The answer to each question is a SINGLE DIGIT INTEGER ranging from 0 to 9, both inclusive.*
- *For each question, darken the bubble corresponding the correct integer in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +3 *If only the bubble corresponding to the correct answer is darkened.*
Zero Marks : 0 *In all other cases.*

8. One mole of an ideal gas is taken from a to b along two paths denoted by the solid and the dashed lines as shown in the graph below. If the work done along the solid line path is w_s and that along the dotted line path is w_d, then the integer closest to the ratio $\frac{w_d}{w_s}$ is

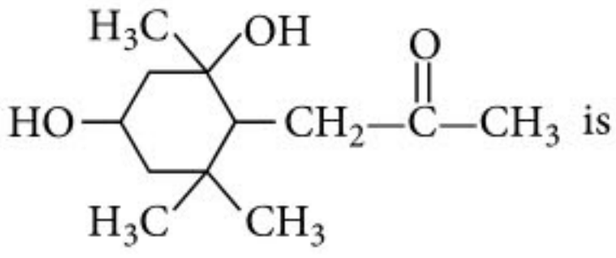


9. The weight of a cubic crystal of NaCl which contains 2.57×10^{21} unit cells is given : NaCl crystallises in *fcc* structure

10. Total net hydrogen atoms which are available for hydrogen bonding from 1°, 2° and 3° amines in an aqueous solution is

11. To 8.4 mL H_2O_2, excess of acidified solution of KI was added. The iodine liberated, required 20 mL of 0.3 N $Na_2S_2O_3$ solution. Volume strength of H_2O_2 solution is

12. Total number of stereoisomers for the compound



is

SECTION 3 (MAXIMUM MARKS : 18)

- *This section contains SIX questions of matching type.*
- *This section contains TWO tables (each having 3 columns and 4 rows).*
- *Based on each table, there are THREE questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +3 *If only the bubble corresponding to the correct option is darkened.*
Zero Marks : 0 *If none of the bubbles is darkened.*
Negative Marks : –1 *In all other cases.*

Answer Q. 13 to 15 by appropriately matching the information given in the three columns of the following table :

Columns 1, 2 and 3 contain reactants, gaseous products and the yield of gaseous products respectively.

Column 1	Column 2	Column 3
(I) $\underset{1\text{ g}}{H_2} + \underset{1\text{ g}}{O_2} \rightarrow$	(i) CH_4	(P) 0.44 g
(II) $\underset{1\text{ g}}{C} + \underset{1\text{ g}}{O_2} \rightarrow$	(ii) CO_2	(Q) 1.125 g
(III) $CaCO_3 \xrightarrow[1\text{ g}]{}$	(iii) NH_3	(R) 1.2 g
(IV) $\underset{1\text{ g}}{N_2} + \underset{1\text{ g}}{H_2} \rightarrow$	(iv) H_2O	(S) 1.375 g

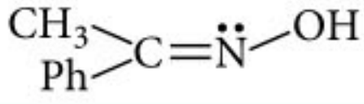
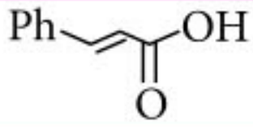
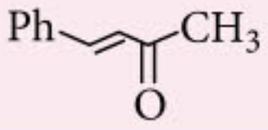
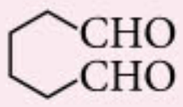
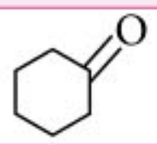
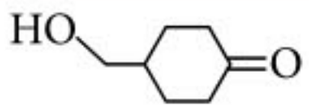
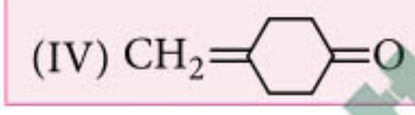
13. Which of the following combinations represents thermal decomposition reaction?
(a) (III)–(iv)–(P) (b) (I)–(i)–(Q)
(c) (II)–(ii)–(S) (d) (III)–(ii)–(P)

14. Which of the following combinations produces highest number of gaseous molecules?
(a) (I)–(iv)–(Q) (b) (II)–(ii)–(S)
(c) (III)–(ii)–(P) (d) (IV)–(iii)–(R)

15. In which of the following combinations product contains maximum number of atoms?
(a) (II)–(ii)–(S) (b) (IV)–(iii)–(R)
(c) (I)–(iv)–(Q) (d) (III)–(ii)–(P)

Answer Q. 16 to 18 by appropriately matching the information given in the three columns of the following table :

Columns 1, 2 and 3 contain reactants, reaction conditions and products respectively.

Column 1	Column 2	Column 3
(I) 	(i) $\xrightarrow[\text{(iii) Reductive ozonolysis}]{\text{(i) LAH (ii) Conc. } H_2SO_4/\Delta}$	(P) 
(II) 	(ii) $\xrightarrow[\text{(ii) } H_2O]{\text{(i) } H^+}$	(Q) 
(III) 	(iii) $\xrightarrow[\text{(ii) } H_2O_2/OH^-]{\text{(i) } BH_3/THF}$	(R) 
(IV) 	(iv) $\xrightarrow{ClO^- + H_3O^+}$	(S) $CH_3COOH + PhNH_2$

16. Which combination is correct?
(a) (I)–(i)–(R) (b) (II)–(iv)–(Q)
(c) (III)–(i)–(Q) (d) (IV)–(ii)–(R)

17. Which combination will follow Beckmann rearrangement?
(a) (I)–(ii)–(R) (b) (I)–(ii)–(S)
(c) (IV)–(iii)–(S) (d) (II)–(ii)–(P)

18. Which of the following combinations will lead to the product containing minimum number of α-hydrogen?
(a) (II)–(iv)–(P) (b) (IV)–(iii)–(P)
(c) (I)–(ii)–(S) (d) (III)–(i)–(Q)

PAPER - II

SECTION 1 (Maximum Marks : 21)

- *This section contains SEVEN questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

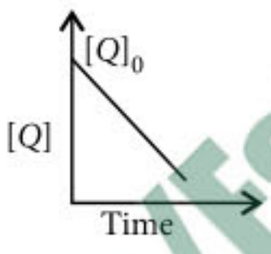
Full Marks : +3 *If only the bubble corresponding to the correct option is darkened.*
Zero Marks : 0 *If none of the bubbles is darkened.*
Negative Marks : –1 *In all other cases.*

1. The radii of two of the first four Bohr's orbits of the hydrogen atom are in the ratio 1 : 4. The energy difference between them may be
(a) either 12.09 eV or 10.2 eV
(b) either 2.55 eV or 10.2 eV
(c) either 13.6 eV or 3.4 eV
(d) either 3.4 eV or 0.85 eV.

2. In the given reaction,

$$P + Q \longrightarrow R + S$$

the time taken for 75% reaction of P is twice the time taken for 50% reaction of P. The concentration of Q varies with reaction time as shown in given figure. The overall order of the reaction is



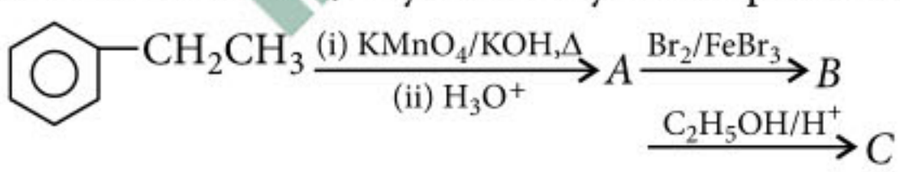
(a) 2 (b) 3
(c) 0 (d) 1

3. Enthalpy is equal to

(a) $T^2\left[\frac{\partial(G/T)}{\partial T}\right]_P$ (b) $-T^2\left[\frac{\partial(G/T)}{\partial T}\right]_P$

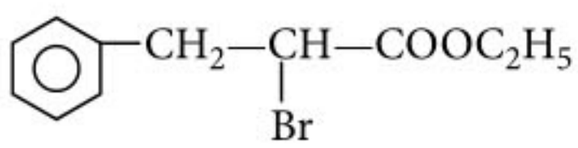
(c) $T^2\left[\frac{\partial(G/T)}{\partial T}\right]_V$ (d) $-T^2\left[\frac{\partial(G/T)}{\partial T}\right]_V$

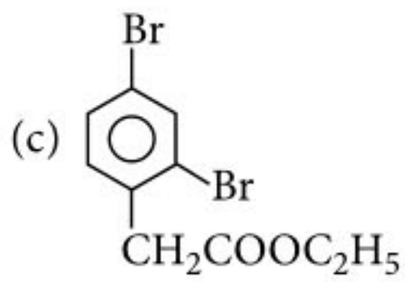
4. In a set of reactions, ethyl benzene yielded a product D.

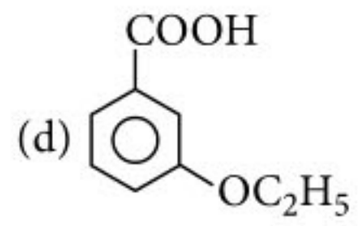


'C' should be

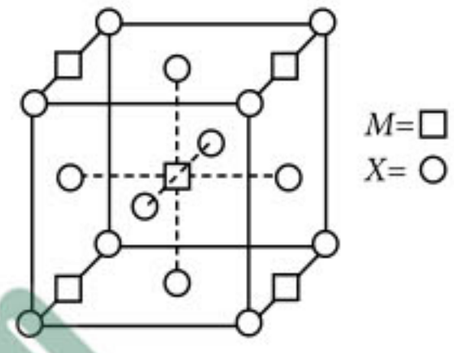
(a) 

(b) 

(c) 

(d) 

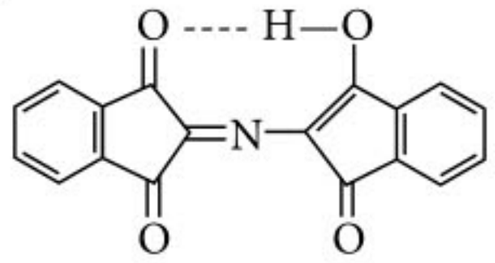
5. A compound M_pX_q has cubic close packing (ccp) arrangement of X. Its unit cell structure is shown in the given figure. The empirical formula of the compound is

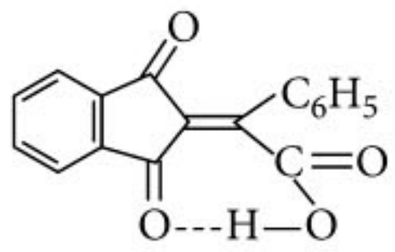


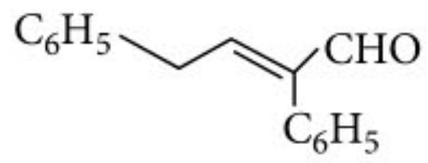
(a) MX (b) MX_2 (c) M_2X (d) M_5X_{14}

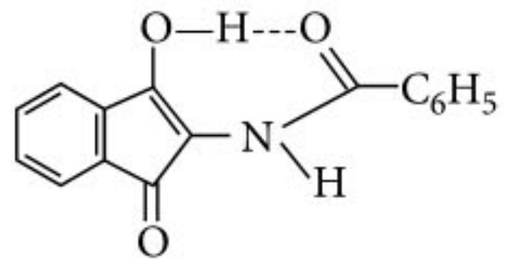
6. Ratio of σ and π bonds is maximum in
(a) naphthalene (b) tetracyanomethane
(c) enolic form of urea (d) salicylic acid.

7. Ninhydrin reagent reacts with α – amino acids to give purple colour. In the reaction of ninhydrin with phenylalanine, which of the following is responsible for this colour?

(a) 

(b) 

(c) 

(d) 

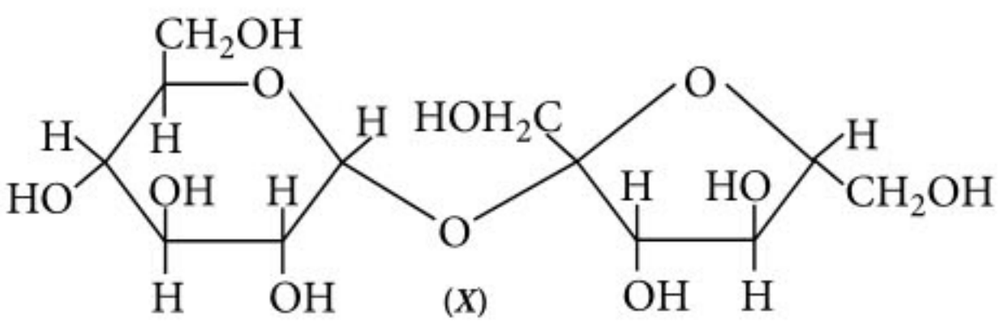
SECTION 2 (MAXIMUM MARKS : 28)

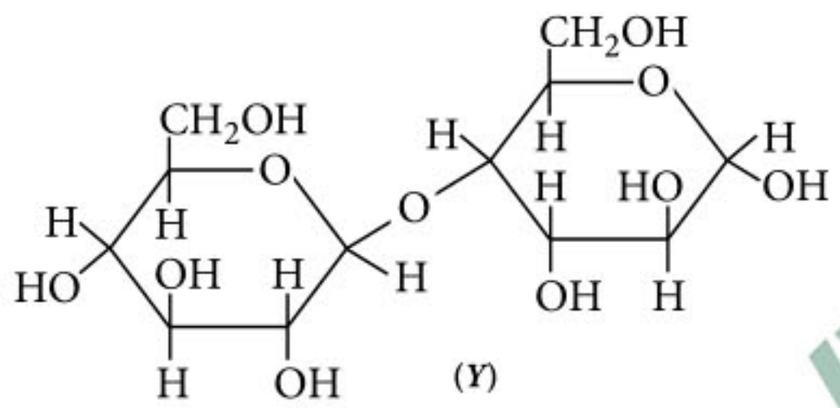
- *This section contains SEVEN questions.*
- *Each question has FOUR options (a), (b), (c) and (d). ONE OR MORE THAN ONE of these four option(s) is(are) correct.*
- *For each question, darken the bubble(s) corresponding to all the correct option(s) in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +4 *If only the bubble(s) corresponding to all the correct option(s) is(are) darkened.*
Partial Marks : +1 *For darkening a bubble corresponding to each correct option, provided NO incorrect option is darkened.*
Zero Marks : 0 *If none of the bubbles is darkened.*
Negative Marks : –2 *In all other cases.*

- *For example, if (a), (c), and (d) are all the correct options for a question, darkening all these three will get +4 marks; darkening only (a) and (d) will get +2 marks; and darkening (a) and (b) will get –2 marks, as a wrong option is also darkened.*

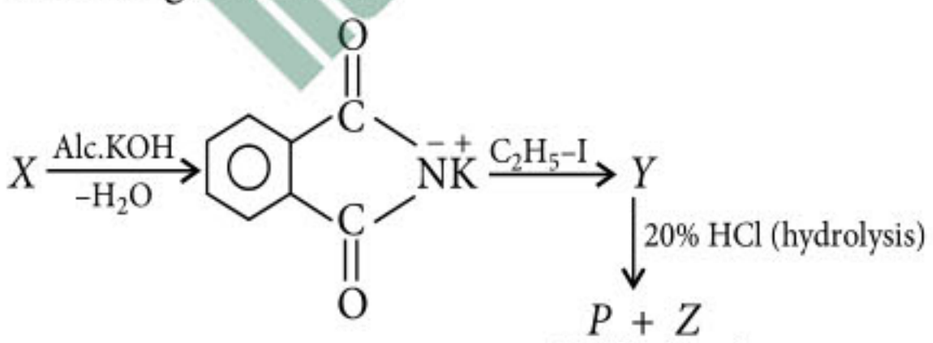
8. The correct statement(s) about the following sugars *X* and *Y* is (are)





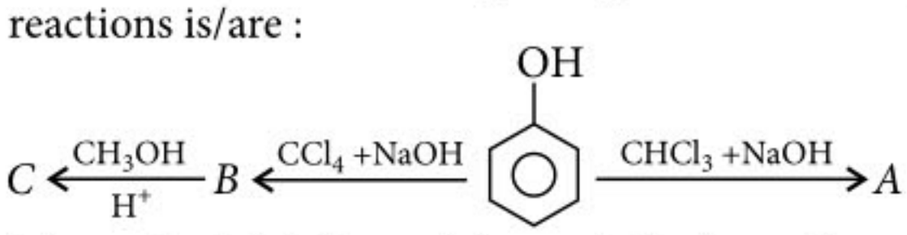
(a) *X* is a reducing sugar and *Y* is a non-reducing sugar.
(b) *X* is non-reducing sugar and *Y* is reducing sugar.
(c) The glucosidic linkages in *X* and *Y* are α and β, respectively.
(d) The glucosidic linkages in *X* and *Y* are β and α, respectively.

9. Which statement(s) is/are correct regarding the reaction given below?



(a) Compound *Y* is *N*,*N*-diethylphthalimide.
(b) Compound *X* can be obtained by reacting *P* with ammonia.
(c) Compound *Z* is a primary amine.
(d) Compound *Y* is obtained by *E*2-mechanism.

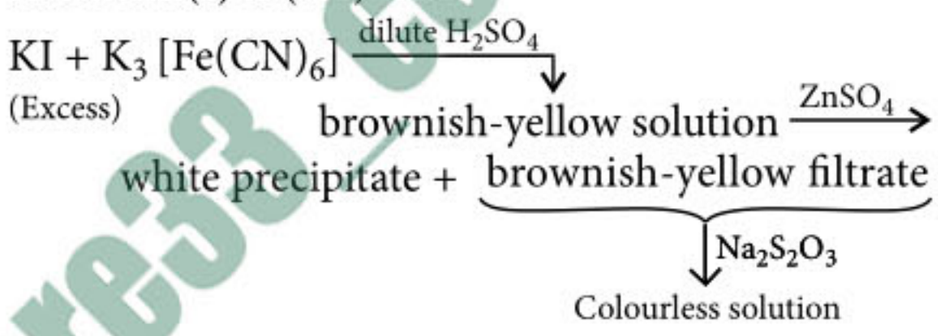
10. Correct statement(s) regarding the following reactions is/are :



(a) product *A* is formed through the formation of dichlorocarbene
(b) product *A* is cinnamic acid
(c) product *B* is salicylic acid
(d) product *C* is oil of wintergreen.

11. Ionic radii of
(a) $Ti^{4+} < Mn^{7+}$ (b) $^{35}Cl^- < {}^{37}Cl^-$
(c) $K^+ > Cl^-$ (d) $P^{3+} > P^{5+}$

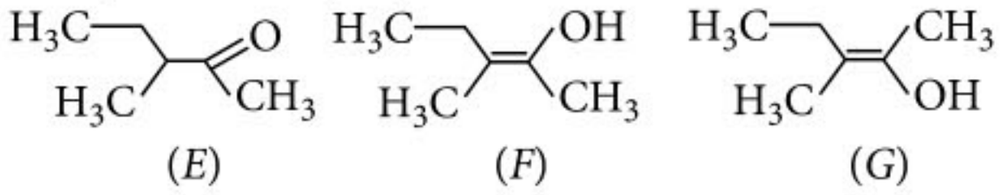
12. For the given aqueous reactions, which of the statement(s) is (are) true?



(a) The first reaction is a redox reaction.
(b) White precipitate is $Zn_3[Fe(CN)_6]_2$.
(c) Addition of filtrate to starch solution gives blue colour.
(d) White precipitate is soluble in NaOH solution.

13. In nitroprusside ion, the iron and NO exist as Fe^{II} and $\overset{+}{N}O$ rather than Fe^{III} and NO. These forms can be differentiated by
(a) estimating the concentration of iron
(b) measuring the concentration of CN
(c) measuring the solid state magnetic moment
(d) thermally decomposing the compound.

14. The correct statement(s) concerning the structures *E*, *F* and *G* is (are)



(*E*) (*F*) (*G*)

(a) *E*, *F* and *G* are resonance structures
(b) *E*, *F* and *E*, *G* are tautomers
(c) *F* and *G* are geometrical isomers
(d) *F* and *G* are diastereomers.

SECTION 3 (Maximum Marks : 12)

- *This section contains TWO paragraphs.*
- *Based on each paragraph, there are TWO questions.*
- *Each question has Four options (a), (b), (c) and (d). ONLY ONE of these four options is correct.*

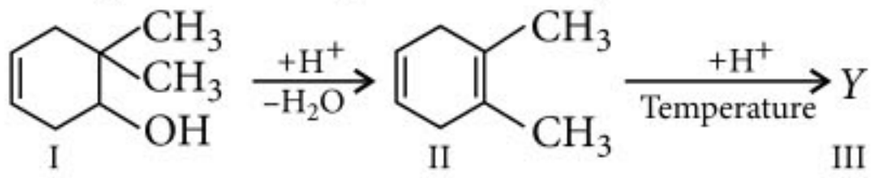
- *For each question, darken the bubble corresponding to the correct option in the ORS.*
- *For each question, marks will be awarded in one of the following categories :*

Full Marks : +3 *If only the bubble corresponding to the correct option is darkened.*

Zero Marks : 0 *In all other cases.*

Paragraph 1

A hydrocarbon whose molecules contain two double bonds is simply called diene. Conjugated dienes are thermodynamically more stable than isolated dienes. Following reaction sequence is the synthesis of a diene.

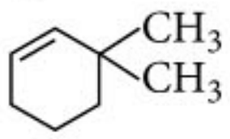
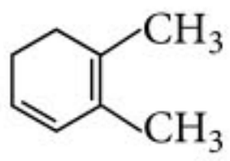


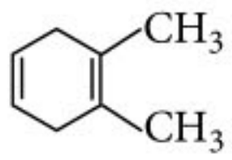
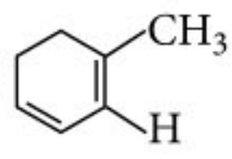
I II III

15. The number of carbocation(s) formed in the conversion I to II is

(a) 1 (b) 4 (c) 2 (d) 3

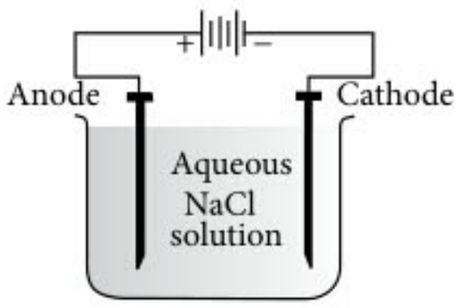
16. Compound *Y* is

(a)  (b) 

(c)  (d) 

Paragraph 2

A direct current of 25 A with a current efficiency of 62% is passed through 20 L of NaCl solution (20% by weight) :



$2H^+_{(aq)} + 2e^- \longrightarrow H_{2(g)}$ $E^\circ = 0.00$ V

$Na^+_{(aq)} + e^- \longrightarrow Na_{(s)}$ $E^\circ = -2.71$ V

$2H_2O_{(l)} + 2e^- \longrightarrow H_{2(g)} + 2OH^-_{(aq)}$ $E^\circ = -0.83$ V

$4H^+_{(aq)} + O_{2(g)} + e^- \longrightarrow 2H_2O_{(l)}$ $E^\circ = 1.23$ V

$Cl_{2(g)} + 2e^- \longrightarrow 2Cl^-$ $E^\circ = 1.36$ V

(Assume no loss in volume due to evaporation)

17. The E°_{cell} for the electrolytic cell is

(a) 1.36 V (b) −1.36 V (c) 2.19 V (d) −2.19 V

18. How long the electrolysis will take to produce 1 kg of Cl_2 ?

(a) 27.1 h (b) 31.0 h (c) 39.6 h (d) 48.71 h

SOLUTIONS

PAPER - I

1. (b): $Pt|H_2(1\ atm)|HA_2||HA_1|H_2(1\ atm)|Pt$

At anode : $E_{(H^+/H_2)_2} = E^\circ_{(H^+/H_2)_2} + 0.059\ (pH)_2$

At cathode : $E_{(H^+/H_2)_1} = E^\circ_{(H^+/H_2)_1} + 0.059\ (pH)_1$

We know, $[H^+] = C\alpha = \sqrt{K_aC}$, $(pH = -\log[H^+])$

$$pH_1 = \frac{1}{2}pK_{a_1} - \frac{1}{2}\log C$$

$$pH_2 = \frac{1}{2}pK_{a_2} - \frac{1}{2}\log C$$

$$E_{cell} = E_{(H^+/H_2)_1} - E_{(H^+/H_2)_2}$$

$$= 0.059\left[\frac{1}{2}pK_{a_2} - \frac{1}{2}pK_{a_1}\right] = \frac{0.059}{2}(5-3) = 0.059\,V$$

2. (a, b, c) : Since vessel is thermally insulated, *i.e.*, the process is adiabatic hence, $q = 0$.

Also, $P_{ext} = 0$, hence $w = 0$

From 1st law of thermodynamics, $\Delta E = q + w$

$\therefore \quad \Delta E = 0$

$\therefore \quad \Delta T = 0 \quad$ or $\quad T_2 = T_1$

[$\because$ Internal energy of an ideal gas is a function of temperature.]

Applying ideal gas equation, $PV = nRT$

where n, R and T are constant.

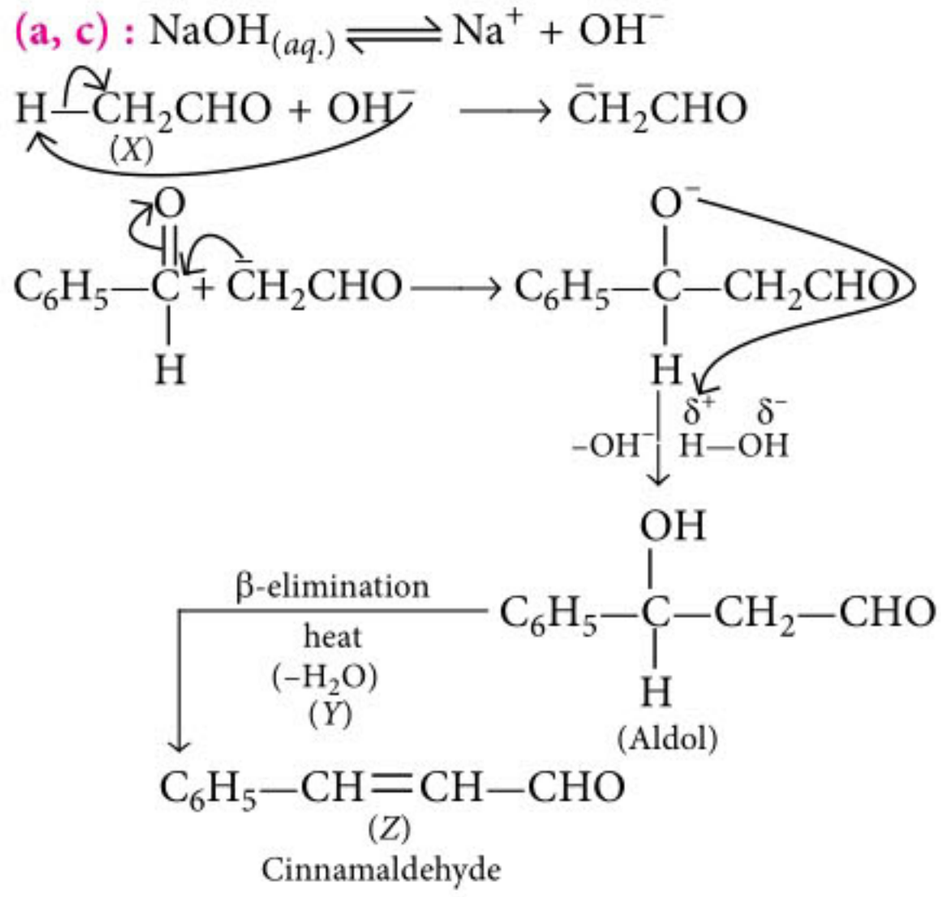
then $P_1V_1 = P_2V_2$

Equation, PV^γ = constant, is applicable only for ideal gas in reversible adiabatic process.

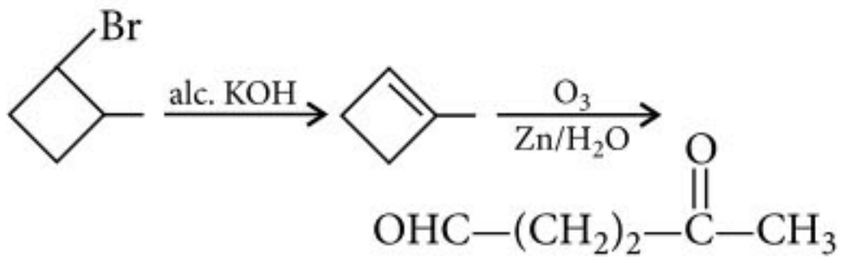
Hence, $P_2V_2^\gamma = P_1V_1^\gamma$ equation is not applicable.

3. (a) : Cellulose is a linear-chain polysaccharide of *D*-glucose which is joined by β-glycosidic linkage between C-1 of one glucose and C-4 of the next glucose. In one unit, only three —OH groups are free to undergo acetylation to form cellulose triacetates.

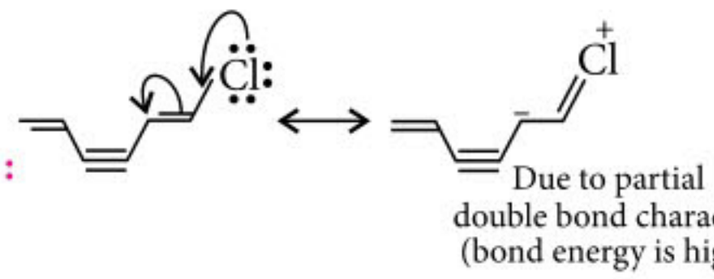
4. (a, c) : $NaOH_{(aq.)} \rightleftharpoons Na^+ + OH^-$



5. (b):



6. (b, d) :



Due to partial double bond character (bond energy is high)

Moreover, resonance involves the delocalisation of only charge or electrons but not the atoms.

7. (a,b,c) : Due to the presence of double bond character in *p*-nitrochlorobenzene and high bond dissociation enthalpy, it does not show coupling reaction like all three.

8. (2): The solid line represents an isotherm as the product of PV is constant throughout. The product of PV is (4 atm) (0.5 L) *i.e.*, 2 atm L. The work done along the solid line is equal to area under the line and is given by the expression :

$$-w_s = n(RT)\ln\left(\frac{V_2}{V_1}\right)$$

$$= (1 \text{ mol})\ (2 \text{ atm L mol}^{-1})\ln\left(\frac{5.5}{0.5}\right)$$

$$= 4.794 \text{ L atm} \qquad (\because PV = RT)$$

The work done along the dotted line (which is sum of the areas under each line) is

$-w_d = P\Delta V$

$-w_d$ = (4 atm) [(2.0 – 0.5) L] + (1 atm) [(3.0 – 2.0) L] + (0.6 atm)[(5.5 – 3.0) L]

= (6 + 1 + 1.5) L atm = 8.5 L atm

$$\frac{(-w_d)}{(-w_s)} = \frac{8.5}{4.794} = 1.77 \approx 2$$

9. (1): Weight of cubic crystal

= No. of unit cells × Mass of one unit cell

Mass of one unit cell = 4 × mass of 1 NaCl formula unit

$$= \frac{4\times58.5}{6.022\times10^{23}}\text{ g} = 3.885\times10^{-22}\text{ g}$$

Thus, weight of cubic crystal

$$= 2.57\times10^{21}\times3.885\times10^{-22}$$

$$= 9.98\times10^{-1} \simeq \frac{10}{10} = 1\text{ g}$$

10. (6)

11. (4): $H_2O_2 + 2I^- + 2H^+ \longrightarrow 2H_2O + I_2$

$I_2 + 2S_2O_3^{2-} \longrightarrow S_4O_6^{2-} + 2I^-$

$N_1V_1 = N_2V_2$

(H_2O_2) $(Na_2S_2O_3)$

$N_1 \times 8.4 = 0.3 \times 20 \Rightarrow N_1 = 0.7143$ N

Normality of H_2O_2 is related to x (*i.e.*, volume strength) by relation,

$$N = \frac{x}{5.6} \Rightarrow x = N_1\times5.6 = 0.7143\times5.6 = 4$$

Type of Academic Programs Offered at IITs on the basis of JEE Advanced

Programs	Full Form	Minimum Duration
B. Tech.	Bachelor of Technology	4 years
B.S.	Bachelor of Science	4 years
B. Arch.	Bachelor of Architecture	5 years
Dual Degree B. Tech.- M.Tech.	Dual Degree Bachelor of Technology and Master of Technology	5 years
Dual Degree B.S. - M.S.	Dual Degree Bachelor of Science and Master of Science	5 years
Integrated M. Tech.	Integrated Master of Technology	5 years
Integrated M. Sc.	Integrated Master of Science	5 years

For more information, refer to latest prospectus of JEE Advanced.

Note: Only those academic programs for which admission is based on JEE (Advanced) examination are shown here. These Institutes also have other academic programs, viz., B.Des., M. Tech., M.Sc., M.Des., Ph. D., etc. with different admission criteria.

12. (8) : It has three chiral carbons, hence number of stereoisomers will be 8.

13. (d): $\underset{1\text{ g}}{CaCO_3} \xrightarrow{\Delta} CaO_{(s)} + CO_{2(g)}$

100g $CaCO_3$ gives = 56 g CaO and 44 g CO_2

∴ 1 g $CaCO_3$ will give 0.56 g of CaO and 0.44 g of CO_2 respectively.

14. (d): (a) $\underset{1\text{ g}}{2H_2} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.125\text{ g}}{2H_2O}$; O_2 is limiting reagent.

18 g of $H_2O = 6.022 \times 10^{23}$ molecules of H_2O

$$1.125 \text{ g of } H_2O = \frac{6.022\times10^{23}}{18}\times1.125$$

$$= 0.38 \times 10^{23} \text{ molecules}$$

(b) $\underset{1\text{ g}}{C} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.375\text{ g}}{CO_2}$; O_2 is limiting reagent

44 g of $CO_2 = 6.022 \times 10^{23}$ molecules of CO_2

$$1.375 \text{ g of } CO_2 = \frac{6.022\times10^{23}}{44}\times1.375$$

$$= 0.19 \times 10^{23} \text{ molecules}$$

(c) $\underset{1\text{ g}}{CaCO_3} \longrightarrow CaO + \underset{0.44\text{ g}}{CO_2}$

44 g of $CO_2 = 6.022 \times 10^{23}$ molecules of CO_2

$$0.44 \text{ g of } CO_2 = \frac{6.022\times10^{23}}{44}\times0.44$$

$$= 0.06 \times 10^{23} \text{ molecules}$$

(d) $\underset{1\text{ g}}{N_2} + \underset{1\text{ g}}{3H_2} \longrightarrow \underset{1.2\text{ g}}{2NH_3}$

17 g of $NH_3 = 6.022 \times 10^{23}$ molecules of NH_3

$$1.2 \text{ g of } NH_3 = \frac{6.022\times10^{23}}{17}\times1.2$$

$$= 0.42 \times 10^{23} \text{ molecules}$$

15. (b): (a) $\underset{1\text{ g}}{C} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.375\text{ g}}{CO_2}$

44 g $CO_2 = 3\ N_A$ atoms

$$1.375 \text{ g } CO_2 = \frac{3}{44}\times1.375\ N_A \text{ atoms}$$

$$= 0.094\ N_A \text{ atoms}$$

(b) $\underset{1\text{ g}}{N_2} + \underset{1\text{ g}}{3H_2} \longrightarrow \underset{1.2\text{ g}}{2NH_3}$

17 g $NH_3 = 4\ N_A$ atoms

$$1.2 \text{ g } NH_3 = \frac{4}{17}\times1.2\ N_A \text{ atoms}$$

$$= 0.28\ N_A \text{ atoms}$$

(c) $\underset{1\text{ g}}{2H_2} + \underset{1\text{ g}}{O_2} \longrightarrow \underset{1.125\text{ g}}{2H_2O}$

18 g $H_2O = 3\ N_A$ atoms

$$1.125 \text{ g } H_2O = \frac{3}{18}\times1.125\ N_A \text{ atoms}$$

$$= 0.19\ N_A \text{ atoms}$$

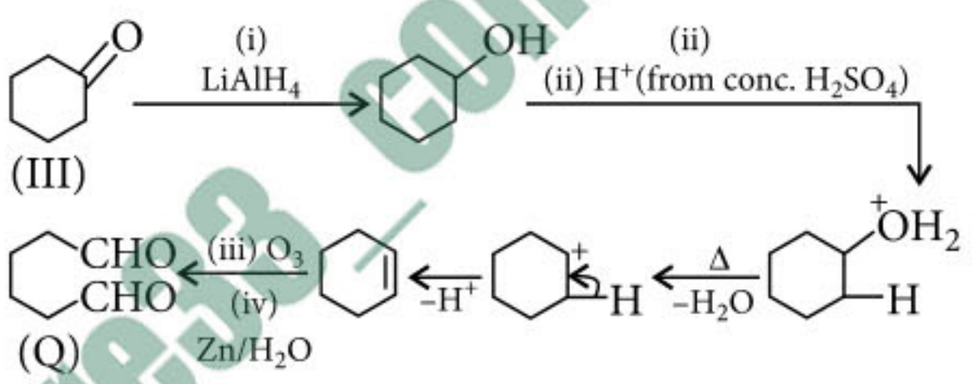
(d) $\underset{1\text{ g}}{CaCO_3} \longrightarrow CaO + \underset{0.44\text{ g}}{CO_2}$

44 g $CO_2 = 3\ N_A$ atoms

$$0.44 \text{ g } CO_2 = \frac{3}{44}\times0.44\ N_A \text{ atoms}$$

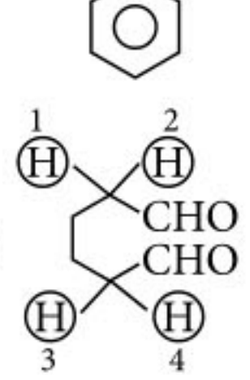
$$= 0.03\ N_A \text{ atoms}$$

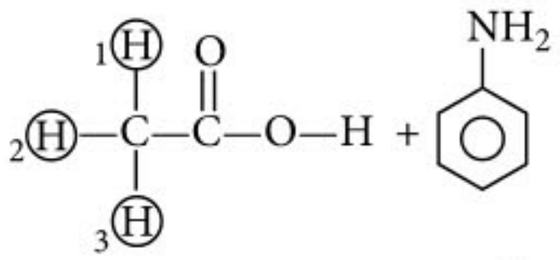
16. (c) :



17. (b)

18. (a) : (P) $CH=\overset{①}{C}H-\overset{O}{\overset{\|}{C}}-OH$ One α-hydrogen

(Q)  Four α-hydrogens

(S)  Three α-hydrogens

PAPER - II

1. (b): $\frac{R_{n_1}}{R_{n_2}} = \frac{n_1^2}{n_2^2} = \frac{1}{4} \quad \therefore \quad \frac{n_1}{n_2} = \frac{1}{2}$

Among the first four orbits n_1 and n_2 can be 1 and 2 or 2 and 4.

$\therefore$ Energy difference can be :

$E_2 - E_1 = 10.2$ eV or $E_4 - E_2 = 2.55$ eV

2. (d): For P, if $t_{50\%} = x$ then $t_{75\%} = 2x$

This is true only for first order reaction.

So, order with respect to P is 1.

The graph shows that amount of the substance reacted is proportional to the time, which is true for zero order reaction. Hence, order with respect to to Q is zero.

So, overall order is $1 + 0 = 1$

3. (b): We know that, $G = H - TS$ ...(i)

$G = E + PV - TS$ $[\because H = E + PV]$

$\Delta G = \Delta E + P\Delta V + V\Delta P - T\Delta S - S\Delta T$

$T\Delta S = \Delta E + P\Delta V$

$\Delta G = V\Delta P - S\Delta T$

At constant pressure, $\Delta P = 0$

$$\frac{\Delta G}{\Delta T} = -S \quad \text{...(ii)}$$

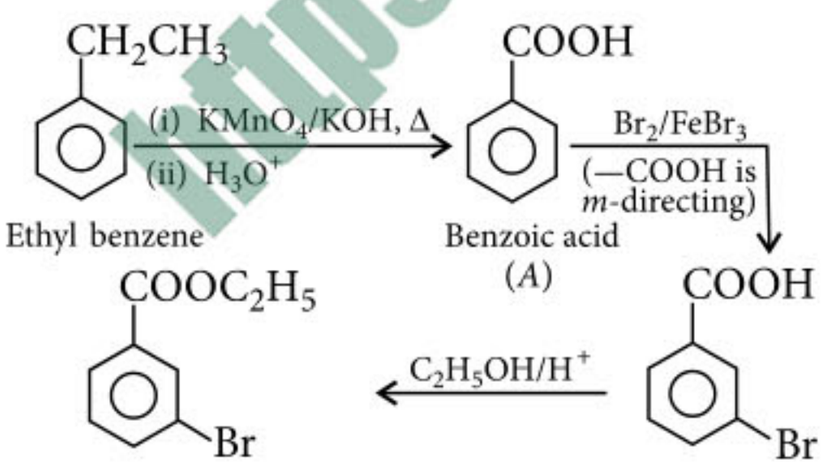
From eqns (i) and (ii),

$$G = H + T\left(\frac{\Delta G}{\Delta T}\right) \text{ or } G = H + T\left(\frac{\partial G}{\partial T}\right)_P$$

$$-\frac{H}{T^2} = -\frac{G}{T^2} + \frac{1}{T}\left(\frac{\partial G}{\partial T}\right)_P = \left[\frac{\partial (G/T)}{\partial T}\right]_P$$

$$H = -T^2\left[\frac{\partial (G/T)}{\partial T}\right]_P$$

4. (a):



5. (b): Contribution by 8 X atoms present at the corners $= \frac{1}{8} \times 8 = 1$

Contribution by 6 X atoms present at the face centres $= 6 \times \frac{1}{2} = 3$

Total X atoms in one unit cell = 3 + 1 = 4

Contribution by 4 M atoms present at edge centres

$$= 4 \times \frac{1}{4} = 1$$

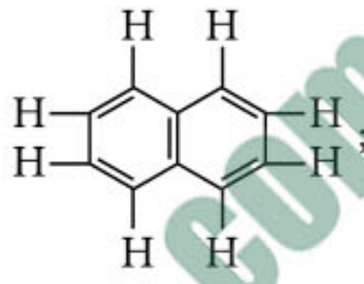
Contribution by 1 M atom present at body centre

$= 1 \times 1 = 1$

Thus, total M atoms in one unit cell = 1 + 1 = 2

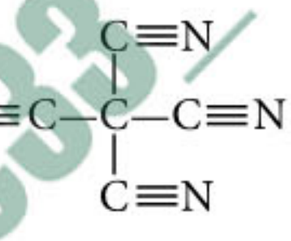
Ratio is $M : X = 2 : 4 = 1 : 2$

Thus, empirical formula is MX_2.

6. (c) : (a)  ; Total σ bonds = 19,

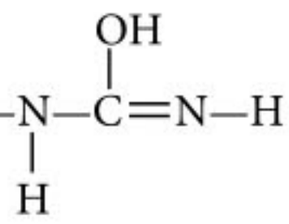
π bonds = 5,

$\text{Ratio} = \frac{19}{5} = 3.8$

(b)  ; Total σ bonds = 8,

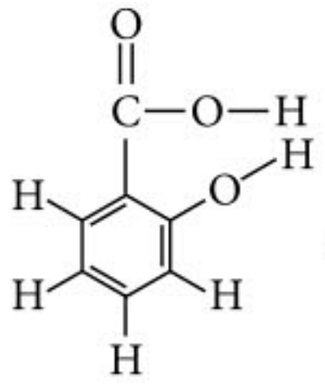
π bonds = 8,

$\text{Ratio} = \frac{8}{8} = 1$

(c)  ; Total σ bonds = 7,

π bonds = 1,

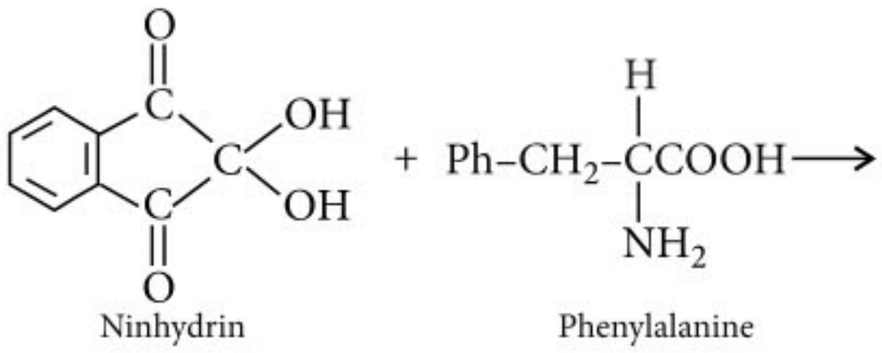
$\text{Ratio} = \frac{7}{1} = 7$

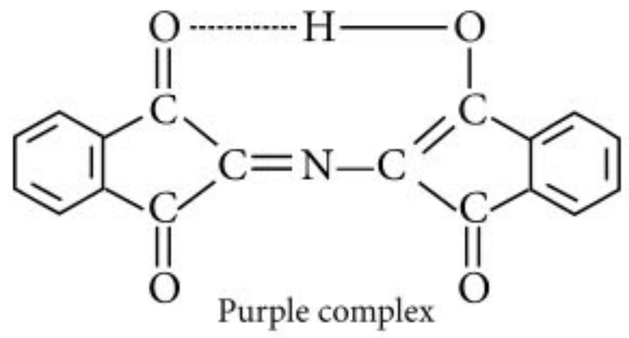
(d)  ; Total σ bonds = 16,

π bonds = 4,

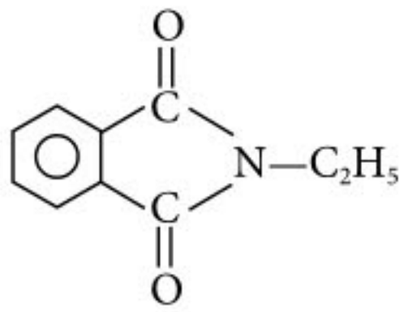
$\text{Ratio} = \frac{16}{4} = 4$

7. (a) :

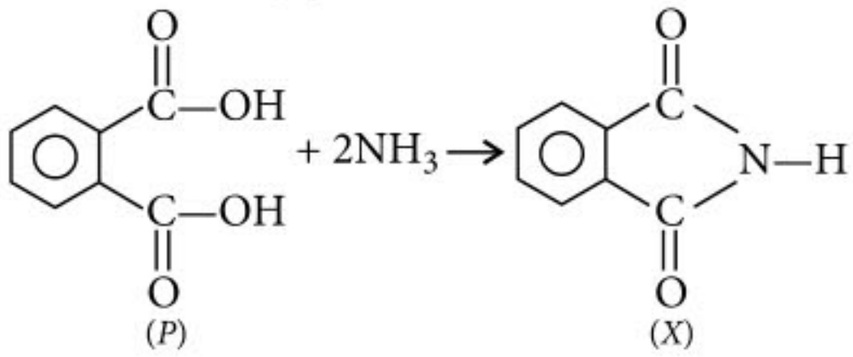




8. (b,c)

9. (b,c) : (a) $Y=$ 

N-ethylphthalimide

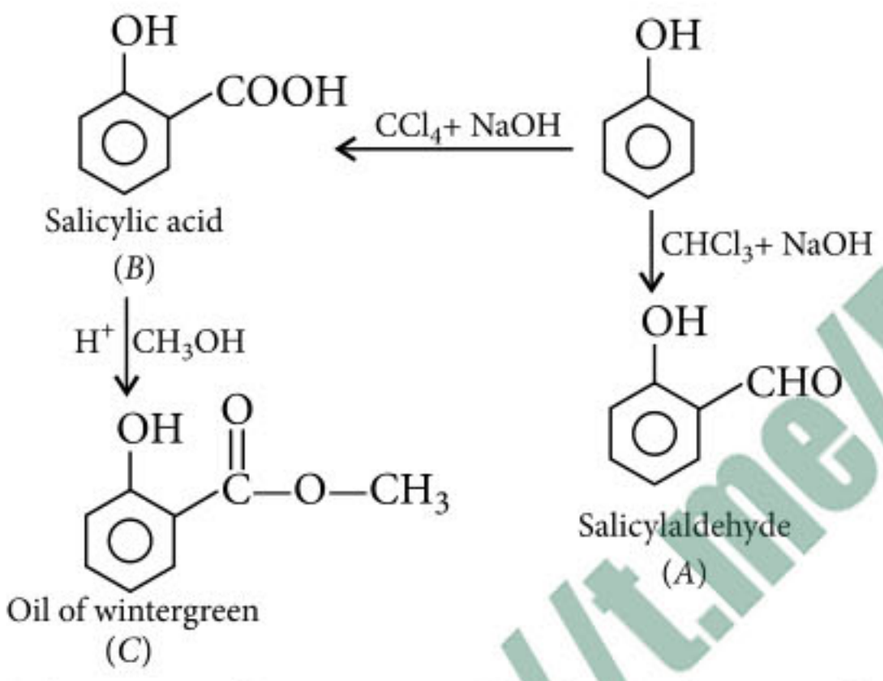
(b) 

(*P*) (*X*)

(c) $Z = C_2H_5—NH_2$ (primary amine)

(d) The phthalimide anion is a strong nucleophile and it reacts with ethyl iodide by an S_N2 mechanism to give an *N*-ethylphthalimide.

10. (a,c,d) :



11. (d): Larger the positive (+) charge, lower will be radii.

12. (a,c,d) : $KI_{(aq)}$ (Excess) $+ K_3[Fe(CN)_6]_{(aq)} \xrightarrow{dil.H_2SO_4}$

$KI_{3(aq)}$ (Brownish-yellow) $+ K_4[Fe(CN)_6]_{(aq)} \xrightarrow{ZnSO_{4(aq)}}$

$K_2Zn_3[Fe(CN)_6]_2$ or $[K_2Zn\{Fe(CN)_6\}]\downarrow$ (White ppt.) $+ KI_{3(aq)}$

$KI_{3(aq)} + Na_2S_2O_3 \longrightarrow I^-_{(aq)} + S_4O^{2-}_{6(aq)}$ (Colourless)

$K_2Zn_3[Fe(CN)_6]_2 + 12NaOH \longrightarrow$

White ppt. $3[Zn(OH)_4]^{2-}_{(aq)} + 2[Fe(CN)_6]^{4-}_{(aq)} + 2K^+$

$KI_3 \rightleftharpoons KI + I_2$

$I_2 \xrightarrow[\text{Solution}]{\text{Starch}}$ Blue coloured complex

13. (c) : Magnetic moment μ is given by

$$\mu = \sqrt{n(n+2)} \text{ B.M.}$$

where, n is the number of unpaired electrons.

Number of unpaired electrons in various species are

Fe^{2+}: $3d^6$ *i.e.* 4 unpaired electrons

Fe^{3+}: $3d^5$ *i.e.* 5 unpaired electrons

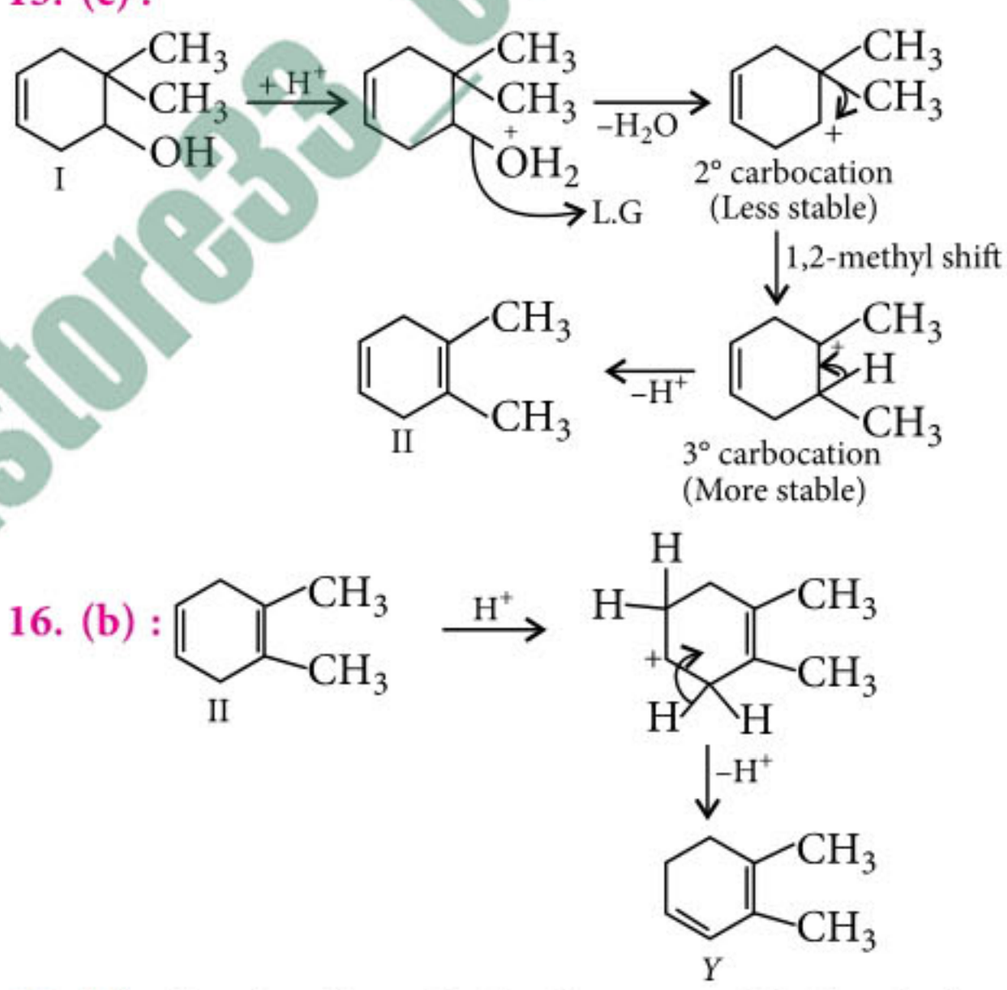
$\overset{+}{N}O$ or $\overset{+}{\underset{\times\times}{N}}=\ddot{O}:$, in this all the electrons are paired.

NO or $\overset{\times}{\times}N\overset{\times\bullet\bullet}{=}O:$, we have a three electron bond so it has an unpaired electron *i.e.* $n = 1$.

Since they (*i.e.* $\overset{+}{N}O$ and NO) have different number of unpaired electrons so they can be differentiated by the measurement of the solid state magnetic moment of nitroprusside ion.

14. (b,c,d) : *E* and *F* as well as *E* and *G* differ in position of H atom, so these are tautomers not resonating structures. *F* and *G* are geometrical isomers and geometrical isomer are diastereomers.

15. (c) :



16. (b) :

II

17. (d) : For the electrolysis of aqueous NaCl solution

At cathode: $2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$ $\quad E^\circ_{red} = -0.83$ V

At anode: $2Cl^- \longrightarrow Cl_2 + 2e^-$ $\quad E^\circ_{ox} = -1.36$ V

$E^\circ_{cell} = E^\circ_{ox} + E^\circ_{red} = -1.36 - 0.83 = -2.19$ V

18. (d) : Weight of Cl_2 = 1 kg = 1000 g

Equivalent weight of Cl_2 = 35.5

Current efficiency = 62 %

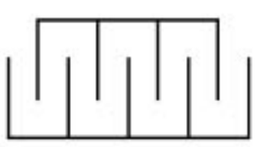
We have, $I = \dfrac{25\times62}{100}$ A

$$w = \frac{E\cdot I\cdot t}{96500} \text{ or } 1000 = \frac{35.5\times25\times62\times t}{100\times96500} = 175,375 \text{ s}$$

$\Rightarrow \quad t = 48.71$ h

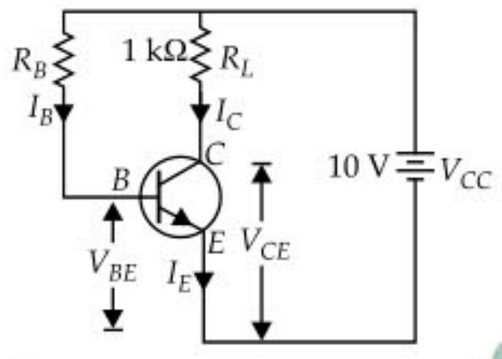
PHYSICS

1. A gang capacitor is formed by inter locking a number of plates as shown in the figure. The distance between the consecutive plates is 0.885 cm and the overlapping area of the plates is 5 cm^2. The capacity of the unit is



(a) 1.06 pF (b) 4 pF
(c) 6.36 pF (d) 12.72 pF

2. In the circuit shown in figure, the current gain, $\beta = 100$ for the transistor. What would be the base resistance R_B so that $V_{CE} = 5$ V? (Neglect V_{BE}).



(a) $2 \times 10^3\ \Omega$ (b) $2 \times 10^5\ \Omega$
(c) $1 \times 10^6\ \Omega$ (d) 500 Ω

3. A body is moving up an inclined plane of angle θ with an initial kinetic energy K. The coefficient of friction between the plane and the body is μ. The work done against friction before the body comes to rest is

(a) $\dfrac{\mu\cos\theta}{K\cos\theta+\sin\theta}$ (b) $\mu K\cos\theta$

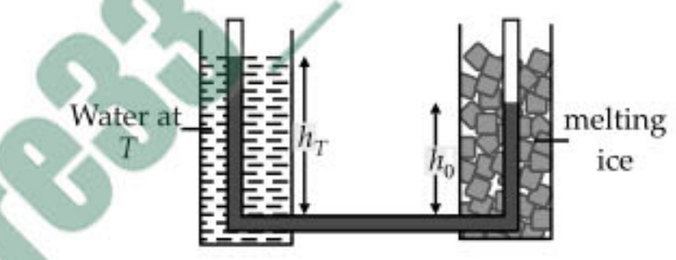
(c) $\dfrac{\mu K\cos\theta}{\mu\cos\theta-\sin\theta}$ (d) $\dfrac{\mu K\cos\theta}{\mu\cos\theta+\sin\theta}$

4. A coil in the shape of an equilateral triangle of side l is suspended between the pole pieces of a permanent magnet, such that $\vec{B}$ is in plane of the coil. If due to a current I in the triangle, a torque $\vec{\tau}$ acts on it, the side l of the triangle is

(a) $\dfrac{2}{\sqrt{3}}\left(\dfrac{\tau}{BI}\right)$ (b) $2\left(\dfrac{\tau}{\sqrt{3}\,BI}\right)^{1/2}$

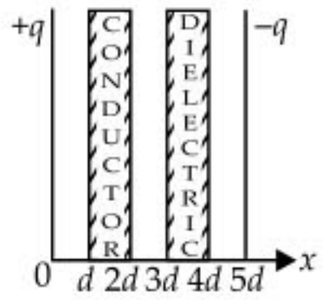
(c) $\dfrac{2}{\sqrt{3}}\left(\dfrac{\tau}{BI}\right)^{1/2}$ (d) $\dfrac{1}{\sqrt{3}}\left(\dfrac{\tau}{BI}\right)$

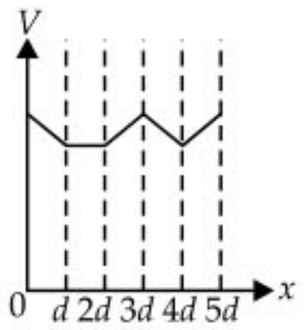
5. In figure shown, left arm of a U-tube is immersed in a hot water bath at temperature T, and right arm is immersed in a bath of melting ice, the height of manometric liquid in respective columns is h_T and h_0. Determine the coefficient of expansion of the liquid.

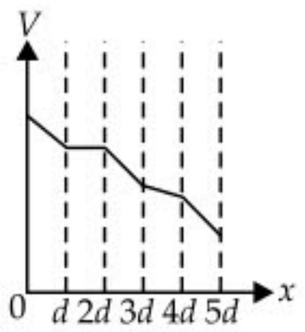


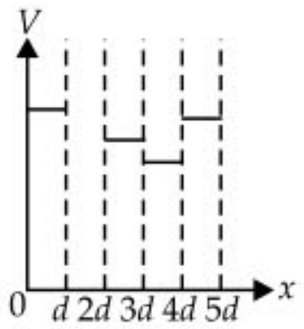
(a) $\dfrac{1}{T}$ (b) $\dfrac{h_T}{h_0 T}$ (c) $\dfrac{h_T-h_0}{h_0 T}$ (d) $\dfrac{h_T+h_0}{h_T T}$

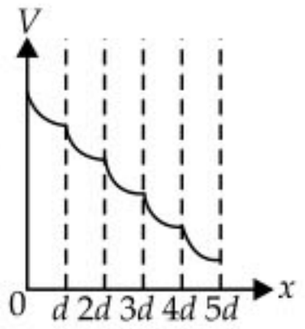
6. The distance between plates of a parallel plate capacitor is $5d$. The positively charged plate is at $x = 0$ and negatively charged plate is at $x = 5d$. Two slabs one of conductor and the other of a dielectric of same thickness d are inserted between the plates as shown in figure. Potential (V) versus distance (x) graph will be



(a)


(b)


(c)


(d)


7. A rigid circular loop of radius r and mass m lies in the x-y plane on a flat table and has a current I flowing in it. At this particular place, the earth's magnetic field is $\vec{B} = B_x\hat{i} + B_z\hat{k}$. What is the value I so that one edge of the loop lifts from the table?

(a) $\dfrac{mg}{\pi r\sqrt{B_x^2 + B_z^2}}$ (b) $\dfrac{mg}{\pi r B_z}$

(c) $\dfrac{mg}{\pi r B_x}$ (d) $\dfrac{mg}{\pi r\sqrt{B_x B_z}}$

8. The frequency of a sonometer wire is υ, but when the weights producing the tensions are completely immersed in water the frequency becomes $\upsilon/2$ and on immersing the weights in a certain liquid the frequency becomes $\upsilon/3$. The specific gravity of the liquid is

(a) $\frac{4}{3}$ (b) $\frac{16}{9}$ (c) $\frac{15}{12}$ (d) $\frac{32}{27}$

9. A particle moves in the x-y plane under the influence of a force such that its linear momentum is $\vec{p}(t) = A[\hat{i}\cos(kt) - \hat{j}\sin(kt)]$, where A and k are constants. The angle between the force and the momentum is

(a) 0° (b) 30° (c) 45° (d) 90°

10. A particle is describing simple harmonic motion. If its velocities are v_1 and v_2 when the displacements from the mean position are y_1 and y_2 respectively, then its time period is

(a) $2\pi\sqrt{\dfrac{y_1^2 + y_2^2}{v_1^2 + v_2^2}}$ (b) $2\pi\sqrt{\dfrac{v_2^2 - v_1^2}{y_1^2 - y_2^2}}$

(c) $2\pi\sqrt{\dfrac{v_1^2 + v_2^2}{y_1^2 + y_2^2}}$ (d) $2\pi\sqrt{\dfrac{y_1^2 - y_2^2}{v_2^2 - v_1^2}}$

11. The mean distance between the atoms of iron is 3×10^{-10} m and interatomic force constant for iron is 7 N m^{-1}. The Young's modulus of elasticity for iron is

(a) 2.33×10^5 N m^{-2} (b) 23.3×10^6 N m^{-2}
(c) 2.33×10^9 N m^{-2} (d) 2.33×10^{10} N m^{-2}

12. The acceleration due to gravity at the poles and the equator is g_p and g_e respectively. If the earth is a sphere of radius R and rotating about its axis with angular speed ω, then $g_p - g_e$ is given by

(a) $\dfrac{\omega^2}{R}$ (b) $\dfrac{\omega^2}{R^2}$ (c) $\omega^2 R^2$ (d) $\omega^2 R$

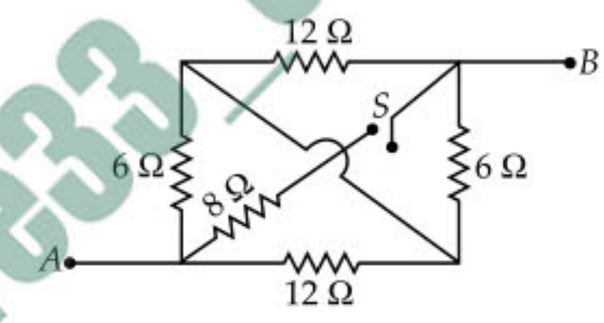
13. A compound microscope has an eye piece of focal length 10 cm and an objective of focal length 4 cm. Find the magnification, if an object is kept at a distance of 5 cm from the objective, so that the final image is formed at the least distance of distinct vision 20 cm.

(a) 12 (b) 11 (c) 10 (d) 13

14. Interference fringes were produced in Young's double slit experiment using light of wavelength 5000 Å. When a film of material 2.5×10^{-3} cm thick was placed over one of the slits, the fringe pattern shifted by a distance equal to 20 fringe widths. The refractive index of the material of the film is

(a) 1.25 (b) 1.33 (c) 1.4 (d) 1.5

15. The equivalent resistance between points A and B with switch S open and closed are respectively



(a) 4 Ω, 8 Ω (b) 8 Ω, 4 Ω
(c) 6 Ω, 9 Ω (d) 9 Ω, 6 Ω

16. A vessel has 6 g of hydrogen at pressure P and temperature 500 K. A small hole is made in it so that hydrogen leaks out. How much hydrogen leaks out if the final pressure is $\frac{P}{2}$ and temperature falls to 300 K?

(a) 2 g (b) 3 g (c) 4 g (d) 1 g

17. A juggler throws balls into air. He throws one whenever the previous one is at its highest point. If he throws n balls each second, the height to which each ball will rise is

(a) $\dfrac{g}{2n^2}$ (b) $\dfrac{2g}{n^2}$ (c) $\dfrac{2g}{n}$ (d) $\dfrac{g}{4n^2}$

18. The electric potential between a proton and an electron is given by $V = V_0 \ln\left(\dfrac{r}{r_0}\right)$, where r_0 is a constant. Assuming Bohr's model to be applicable, write variation of r_n with n, n being the principal quantum number

(a) $r_n \propto n$ (b) $r_n \propto \dfrac{1}{n}$
(c) $r_n \propto n^2$ (d) $r_n \propto \dfrac{1}{n^2}$

19. A circular disk of moment of inertia I_t is rotating in a horizontal plane, about its symmetry axis, with a constant angular speed ω_i. Another disk of moment of inertia I_b is dropped coaxially onto the rotating disk. Initially the second disk has zero angular speed. Eventually both the disks rotate with a constant angular speed ω_f. The energy lost by the initially rotating disc to friction is

(a) $\frac{1}{2}\frac{I_b^2}{(I_t+I_b)}\omega_i^2$ (b) $\frac{1}{2}\frac{I_t^2}{(I_t+I_b)}\omega_i^2$

(c) $\frac{I_b-I_t}{(I_t+I_b)}\omega_i^2$ (d) $\frac{1}{2}\frac{I_bI_t}{(I_t+I_b)}\omega_i^2$

20. A cylindrical metallic rod in thermal contact with two reservoirs of heat at its two ends conducts an amount of heat Q in time t. The metallic rod is melted and the material is formed into a rod of half the radius of the original rod. What is the amount of heat conducted by the new rod, when placed in thermal contact with the two reservoirs in time t?

(a) $\frac{Q}{4}$ (b) $\frac{Q}{16}$ (c) $2Q$ (d) $\frac{Q}{2}$

21. Half-life of a radioactive substance is 20 minute. The time between 20% and 80% decay will be

(a) 20 min (b) 30 min (c) 40 min (d) 25 min

22. When a dc voltage of 200 V is applied to a coil of self inductance $(2\sqrt{3}/\pi)$ H, a current of 1 A flows through it. But by replacing dc source with ac source of 200 V, the current in the coil is reduced to 0.5 A. Then the frequency of ac supply is

(a) 100 Hz (b) 75 Hz (c) 60 Hz (d) 50 Hz

23. Water from a tap (at the end of a horizontal pipe) emerges vertically downwards with an initial speed of 1 m s^{-1}. The cross-sectional area of the tap is 10^{-4} m^2. Assume that the pressure is constant throughout the stream of water and the flow is steady. The cross-sectional area of the stream 0.15 m below the tap is

(a) 5×10^{-4} m^2 (b) 1×10^{-5} m^2

(c) 5×10^{-5} m^2 (d) 2×10^{-5} m^2

24. The escape velocity for a rocket on the Earth is 11.2 km s^{-1}. The escape velocity (in km s^{-1}) from a planet having twice the radius and same mean density is

(a) 11.2 (b) 5.6

(c) 15.2 (d) 22.4

25. Four particles each of mass m are lying symmetrically on the rim of a disc of mass M and radius R. Moment of inertia of this system about an axis passing through one of the particle and perpendicular to plane of disc is

(a) $16mR^2$ (b) $(3M+16m)\frac{R^2}{2}$

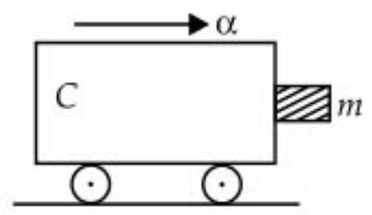
(c) $(3M+12m)\frac{R^2}{2}$ (d) zero

26. If an average person jogs, he produces 14.5×10^3 cal per minute. This is removed by the evaporation of sweat. The amount of sweat evaporated per minute (assuming 1 kg requires 580×10^3 cal for evaporation) is

(a) 0.025 kg (b) 2.25 kg

(c) 0.05 kg (d) 0.20 kg

27. A block of mass m is in contact with the cart C as shown in the figure.



The coefficient of static friction between the block and the cart is μ. The acceleration α of the cart that will prevent the block from falling satisfies

(a) $\alpha > \frac{mg}{\mu}$ (b) $\alpha > \frac{g}{\mu m}$

(c) $\alpha \geq \frac{g}{\mu}$ (d) $\alpha < \frac{g}{\mu}$

28. The maximum wavelength of radiation that can produce photoelectric effect in certain metal is 200 nm. The maximum kinetic energy acquired by electron due to radiation of wavelength 100 nm will be

(a) 12.4 eV (b) 6.2 eV

(c) 100 eV (d) 200 eV

29. The speed of light (c), acceleration due to gravity (g) and pressure (P) are taken as fundamental units, the dimensions of gravitational constant (G) are

(a) $[c^0gP^{-3}]$ (b) $[c^2g^3P^{-2}]$

(c) $[c^0g^2P^{-1}]$ (d) $[c^2g^2P^{-2}]$

30. A body of mass 60 kg is dragged with just enough force to start it moving on a rough surface with coefficients of static and kinetic frictions 0.5 and 0.4 respectively. On applying the same force, the acceleration is

(a) 0.98 m s^{-2} (b) 9.8 m s^{-2}

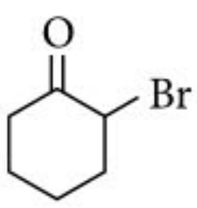
(c) 0.54 m s^{-2} (d) 5.4 m s^{-2}

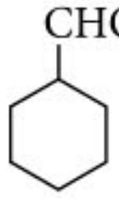
CHEMISTRY

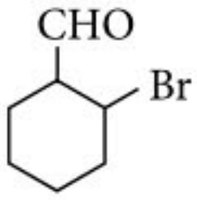
31. Which is the most stable complex?
(a) $[Be(H_2O)_4]^{2+}$ (b) $[Mg(H_2O)_4]^{2+}$
(c) $[Ca(H_2O)_4]^{2+}$ (d) $[Sr(H_2O)_4]^{2+}$

32. Consider the following carbonyl compounds :

I. 

II. 

III. 

IV. 

Which of the following is correct decreasing order of the extent of hydration or towards nucleophilic addition reactions?
(a) (IV) > (III) > (II) > (I)
(b) (I) > (II) > (III) > (IV)
(c) (IV) > (II) > (III) > (I)
(d) (I) > (III) > (II) > (IV)

33. In a normal spinel type structure, the oxide ions are arranged in *ccp*, whereas, 1/8 tetrahedral holes are occupied by Zn^{2+} ions and 50% of octahedral holes are occupied by Fe^{3+} ions. The formula of the compound is
(a) $Zn_2Fe_2O_4$ (b) $ZnFe_2O_3$
(c) $ZnFe_2O_4$ (d) $ZnFe_2O_2$

34. When 80 mL of 0.20 M HCl is mixed with 120 mL of 0.15 M KOH, the resulting solution is the same as a solution of
(a) 0.16 M KCl and 0.02 M HCl
(b) 0.08 M KCl
(c) 0.08 M KCl and 0.01 M KOH
(d) 0.08 M KCl and 0.01 M HCl.

35. A polymer with the high chemical stability has m.pt. 327 °C and the density of complete crystalline sample is 2.3 g/m^3. It can be
(a) PVC (b) teflon
(c) melamine (d) bakelite.

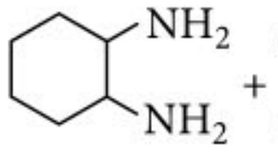
36. Which of the following statements is correct?
(a) E°_{cell} and $\Delta_r G$ of cell reaction both are extensive properties.
(b) E°_{cell} and $\Delta_r G$ of cell reaction both are intensive properties.
(c) E°_{cell} is an intensive property while $\Delta_r G$ of cell reaction is an extensive property.
(d) E°_{cell} is an extensive property while $\Delta_r G$ of cell reaction is an intensive property.

37. Two gases *A* and *B* having the same volume, diffuse through a porous partition in 20 and 10 seconds respectively. The molecular mass of *A* is 49 u. Molecular mas of *B* will be
(a) 50.00 u (b) 12.25 u (c) 6.50 u (d) 25.00 u.

38. Which of the following complexes has the least electrical conductance in aqueous solution?
(a) K_2PtCl_6 (b) $PtCl_4 \cdot 2NH_3$
(c) $PtCl_4 \cdot 3NH_3$ (d) $PtCl_4 \cdot 5NH_3$

39. A compound of mol. wt. 180 is acetylated to give a compound of mol. wt. 390. The number of amino groups in the initial compound is
(a) 2 (b) 4 (c) 5 (d) 6

40. 0.20 mole of NH_4Cl are introduced into an empty container of 10 litre and heated to 327 °C to attain equilibrium as :
$NH_4Cl_{(s)} \rightleftharpoons NH_{3(g)} + HCl_{(g)}$; $K_p = 0.36\ atm^2$.
The quantity of solid NH_4Cl left is
(a) 0.02 mole (b) 0.078 mole
(c) 0.095 mole (d) 0.035 mole.

41. Which of the following will not produce aromatic product?
(a) $Me-C\equiv CH \xrightarrow[\text{Fe tube}]{\text{Red hot}}$
(b) $C_6H_{14} \xrightarrow[Cr_2O_3, \Delta]{Al_2O_3}$
(c)  $\xrightarrow[KOH]{CHCl_3}$
(d) 

42. If K_{sp} of *M*OH is 1×10^{-10}, then pH of its aqueous solution will be
(a) 3 (b) 6 (c) 9 (d) 12

43. Which of the following statements are correct for SO_2 gas?
(a) It acts as bleaching agent in moist conditions.
(b) It has linear geometry.
(c) It's dilute solution is used as lubricant.
(d) It can be prepared by the reaction of dilute H_2SO_4 with metal sulphide.

44. Which of the following is the correct order of decreasing basic nature of oxides?
(a) Na_2O, MgO, Al_2O_3, CuO
(b) CuO, Al_2O_3, MgO, Na_2O
(c) Al_2O_3, CuO, MgO, Na_2O
(d) CuO, MgO, Na_2O, Al_2O_3

45. 50 mL aqueous solution of $FeSO_4$ required 12 mL of 0.02 M $KMnO_4$ in acidic medium for complete oxidation. Calculate the molarity of ferrous sulphate solution. The reaction is

$$MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$$

(a) 0.024 M (b) 0.24 M
(c) 2.4 M (d) 2.4×10^{-3} M

46. Which of the following is incorrect?
(a) Only Lyman series is observed in both emission and absorption spectrum.
(b) The continuum in line spectrum is noticed after a certain value of n.
(c) The wavelength of m^{th} line of Balmer series is $\frac{1}{\lambda} = R_H Z^2 \left[\frac{1}{2^2} - \frac{1}{m^2}\right]$.
(d) The number of spectral lines given when electron drops from 5^{th} to 2^{nd} shell is six.

47. For a particular reversible reaction at temperature T, ΔH and ΔS both were found to be +ve. If T_e is the temperature at equilibrium, the reaction would be spontaneous when
(a) $T = T_e$ (b) $T_e > T$
(c) $T > T_e$ (d) T_e is 5 times T.

48. Consider the following sequence of reactions,

$$(CH_3)_2CHI \xrightarrow[EtOH]{KOH} (A) \xrightarrow[475\ K]{SO_2Cl_2} (B)$$

compound (B) in the sequence is
(a) dimethyl sulphate (b) 1,2-dichloroethane
(c) 1-chloropropene
(d) 1-chloro-2-iodopropane.

49. Which of the following reagents can help in separating a mixture of acetone and CCl_4?
(a) NaOH (b) NaCl
(c) $NaHSO_3$ (d) None of the above

50. Aluminium vessels should not be washed with material containing washing soda because
(a) washing soda reacts with aluminium to form soluble aluminate
(b) washing soda is expensive
(c) washing soda is easily decomposed
(d) washing soda reacts with aluminium to form insoluble aluminium oxide.

51. A certain substance A, is mixed with an equal amount of a substance, B. At the end of 1.0 hr, A is 70% reacted. How much will it be left unreacted at the end of 2.5 hr, if the reaction with respect to A is of first order?
(a) 10% (b) 5%
(c) 3% (d) 1%

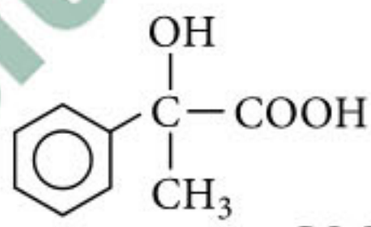
52. Which of the following statements is not correct?
(a) In first transition series, Cr shows highest value of magnetic moment in the ground state.
(b) $[NiCl_4]^{2-}$ and $[PtCl_4]^{2-}$ have different shapes.
(c) $[Ni(CN)_4]^{2-}$ is an outer orbital complex.
(d) $[Ni(CN)_4]^{2-}$ and $[Ni(CO)_4]$ have the same magnetic moment.

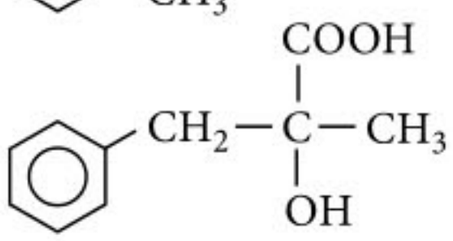
53. For a reaction taking place in three steps, the rate constants are k_1, k_2 and k_3. The overall rate constant $k = \frac{k_1 k_2}{k_3}$. If the energy of activation values for the first, second and third stages are respectively 40, 50 and 60 kJ mol^{-1}, then the overall energy of activation in kJ mol^{-1} is
(a) 30 (b) 40 (c) 60 (d) 50

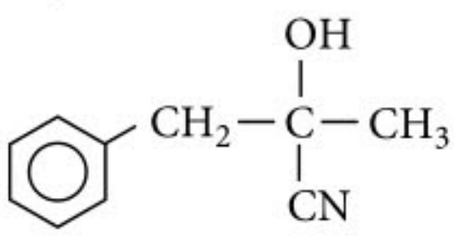
54. In a set of reactions, acid yielded a product D,

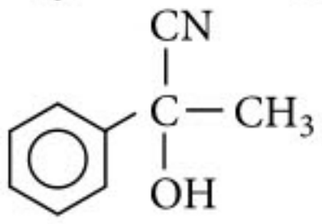
$$CH_3COOH \xrightarrow{SOCl_2} A \xrightarrow[Anhy.\ AlCl_3]{Benzene} B \xrightarrow{HCN} C \xrightarrow{HOH} D$$

identify D.

(a) 

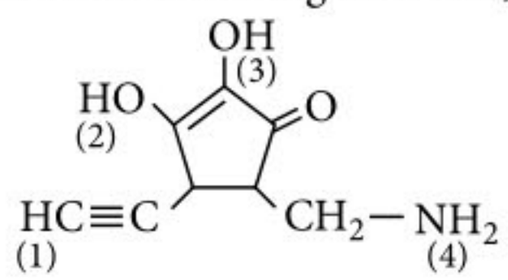
(b) 

(c) 

(d) 

55. A 20 mL urea solution of 2% (w/v) is mixed with 80 mL of glucose solution of 4% (w/v) at 300 K. Calculate the osmotic pressure of the solution.
(a) 6.02 atm (b) 1.642 atm
(c) 4.378 atm (d) 3.01 atm

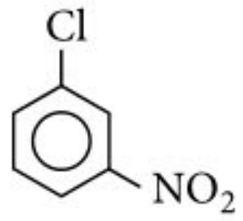
56. For the following molecule,

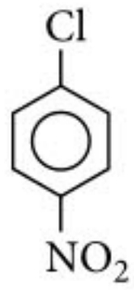


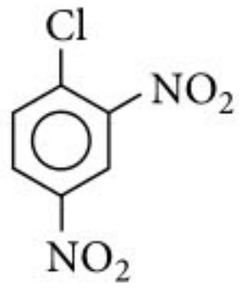
arrange the hydrogens in the decreasing order of acidity.

(a) 1 > 2 > 3 > 4 (b) 4 > 3 > 2 > 1
(c) 2 > 3 > 1 > 4 (d) 2 > 3 > 4 > 1

57. Consider the following compounds with respect to their reactivity towards substitution reactions with C_2H_5ONa/C_2H_5OH.

I. 

II. 

III. 

The reactivity decreases in the order

(a) III > I > II (b) II > I > III
(c) I > II > III (d) III > II > I.

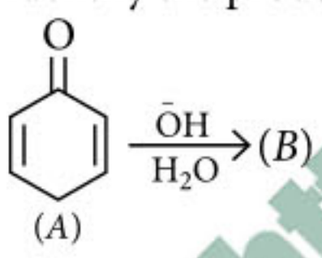
58. In an experiment, addition of 4.0 mL of 0.005 M $BaCl_2$ to 16.0 mL of arsenius sulphide sol just causes complete coagulation in 2 hrs. The flocculating value of the effective ion is

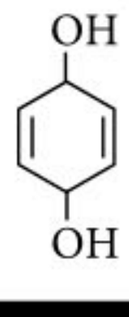
(a) Cl^-, 1.0 (b) Cl^-, 2.0
(c) Ba^{2+}, 1.0 (d) Ba^{2+}, 0.5

59. In the cyanide extraction process of silver from argentite ore, the oxidizing and reducing agents used are

(a) O_2 and CO respectively
(b) O_2 and Zn dust respectively
(c) HNO_3 and Zn dust respectively
(d) HNO_3 and CO respectively.

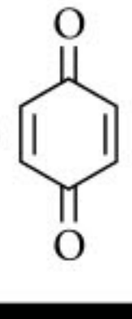
60. Identify the product (B) in the given reaction.



(a) 

(b) 

(c) 

(d) 

MATHEMATICS

61. The ratio of the area enclosed by the locus of mid-point of PS and area of the ellipse where P is any point on the ellipse and S is the focus of the ellipse, is

(a) $\frac{1}{2}$ (b) $\frac{1}{3}$ (c) $\frac{1}{5}$ (d) $\frac{1}{4}$

62. Let $X_n = \left\{z = x + iy : |z|^2 \le \frac{1}{n}\right\}$ for all integers $n \ge 1$.

Then $\bigcap_{n=1}^{\infty} X_n$ is

(a) a singleton set
(b) not a finite set
(c) an empty set
(d) a finite set with more than one element.

63. The area of the smaller region bounded by the curves $x^2 + y^2 = 5$ and $y^2 = 4x$ is

(a) $\frac{\pi}{4} + \frac{1}{6}$ (b) $\frac{\pi}{4} - \frac{1}{6}$
(c) $2\left(\frac{1}{3} - \frac{5}{2}\sin^{-1}\frac{2}{\sqrt{5}}\right)$ (d) $2\left(\frac{1}{3} + \frac{5}{2}\sin^{-1}\frac{2}{\sqrt{5}}\right)$

64. If two independent events A and B are such that $P(A \cap B^C) = \frac{3}{25}$ and $P(A^C \cap B) = \frac{8}{25}$ and $P(A) > \frac{1}{2}$, the value of $P(A) + P(B) =$

(a) $\frac{8}{5}$ (b) $\frac{4}{5}$
(c) $\frac{7}{5}$ (d) None of these

65. Consider points $A(3, 4)$ and $B(7, 13)$. If P be a point on the line $y = x$ such that $PA + PB$ is minimum, then coordinates of P are

(a) $\left(\frac{12}{7}, \frac{12}{7}\right)$ (b) $\left(\frac{13}{7}, \frac{13}{7}\right)$
(c) $\left(\frac{31}{7}, \frac{31}{7}\right)$ (d) (0, 0)

66. For any vector $\vec{r}$, the value of $\hat{i} \times (\vec{r} \times \hat{i}) + \hat{j} \times (\vec{r} \times \hat{j}) + \hat{k} \times (\vec{r} \times \hat{k})$ is

(a) $\vec{0}$ (b) $2\vec{r}$
(c) $-2\vec{r}$ (d) None of these

67. If two circles $(x - 1)^2 + (y - 3)^2 = r^2$ and $x^2 + y^2 - 8x + 2y + 8 = 0$ intersect in two distinct points, then

(a) $2 < r < 8$ (b) $r < 2$
(c) $r > 2$ (d) $r = 2$

68. A function $f : Q^+ \to Q^+$ is defined such that $f(x) + f(y) + 2xyf(xy) = \frac{f(xy)}{f(x+y)}$, then $f(1)$ is equal to

(a) 1 (b) 0
(c) 2 (d) none of these

69. Let $f(x)$ be a polynomial function of second degree. If $f(1) = f(-1)$ and a, b, c, are in A.P., then $f'(a), f'(b)$ and $f'(c)$ are in

(a) A.P. (b) G.P.
(c) H.P. (d) None of these

70. If $\begin{vmatrix} x+1 & x+2 & x+a \\ x+2 & x+3 & x+b \\ x+3 & x+4 & x+c \end{vmatrix} = 0$, then a, b, c are

(a) equal (b) in A.P.
(c) in G.P. (d) in H.P.

71. If $(1+x)^n = C_0 + C_1x + C_2x^2 + \ldots\ldots + C_n x^n$, then the value of $\frac{C_0}{1} + \frac{C_1}{2} + \frac{C_2}{3} + \ldots\ldots + \frac{C_n}{n+1}$ is

(a) 2^{n+1} (b) $\frac{2^n - 1}{n+1}$
(c) $\frac{2^{n+1} - 1}{n+1}$ (d) $\frac{2^{n+1}}{n+1}$

72. Let $f : R \to R$ defined by

$f(x) = x^3 + x^2 + 100x + 5\sin x$, then f is

(a) many one onto (b) many-one into
(c) one-one onto (d) one-one into

73. $\vec{a}$ and $\vec{b}$ are such that $|\vec{a}| = 1, |\vec{b}| = 4, \vec{a} \cdot \vec{b} = 2$. If $\vec{c} = (2\vec{a} \times \vec{b} - 3\vec{b})$, then angle between $\vec{b}$ and $\vec{c}$ is

(a) $\frac{\pi}{6}$ (b) $\frac{5\pi}{6}$ (c) $\frac{\pi}{3}$ (d) $\frac{2\pi}{3}$

74. If $A = \begin{bmatrix} a & b & c \\ x & y & z \\ p & q & r \end{bmatrix}$ and $B = \begin{bmatrix} q & -b & y \\ -p & a & -x \\ r & -c & z \end{bmatrix}$ then

(a) $|A| = |B|$ (b) $|A| = -|B|$
(c) $|A| = 2|B|$ (d) none of these

75. Number of solutions of the equation $4\sin^2 x + \tan^2 x + \cot^2 x + \text{cosec}^2 x = 6$ in $[0, \pi]$ is

(a) 0 (b) 2 (c) 8 (d) 4

76. In what direction a line be drawn through the point (1, 2) so that its points of intersection with the line $x + y = 4$ is at a distance $\frac{\sqrt{6}}{3}$ from the given point

(a) 30° (b) 45° (c) 60° (d) 75°

77. The value of $\lim_{n\to\infty}\left[\frac{2n}{2n^2 - 1}\cos\frac{n+1}{2n-1} - \frac{n}{1-2n}\cdot\frac{n(-1)^n}{n^2+1}\right]$ is

(a) 1 (b) –1
(c) 0 (d) none of these

78. Let $f(x) = \lim_{n\to\infty} \frac{\log_e(2+x) - x^{2n}\sin x}{1 + x^{2n}}$ then

(a) $f(x)$ is continuous at $x = 1$
(b) $\lim_{x\to 1^+} f(x) = \log_e 3$
(c) $\lim_{x\to 1^+} f(x) = -\sin 1$
(d) $\lim_{x\to 1^-} f(x)$ does not exist

79. A ray of light incident at the point (–2, –1) gets reflected from the tangent at (0, –1) to the circle $x^2 + y^2 = 1$. The reflected ray touches the circle. The equation of the line along which the incident ray moved is

(a) $4x - 3y + 11 = 0$ (b) $4x + 3y + 11 = 0$
(c) $3x - 4y + 11 = 0$ (d) none of these

80. If $\int_2^4 \frac{\sqrt{x^2 - 4}}{x^2} dx = \log\alpha + \beta$, then which of the following is true ?

(a) $\alpha + 2\beta$ is rational
(b) $\alpha = 2(1 - \beta)$
(c) (α, β) lies on $x^2 - 4y^2 = 4(x - 1)$
(d) all of these

81. If α, β are roots of $ax^2 + 2bx + c = 0$ and γ, δ are the roots of $px^2 + 2qx + r = 0$. If $\alpha, \beta, \gamma, \delta$ are in A.P., then $\frac{b^2 - ac}{q^2 - pr}$ equals

(a) $\frac{a^2}{p^2}$ (b) $\frac{b^2}{q^2}$
(c) $\frac{c^2}{r^2}$ (d) None of these

82. The value of $\tan^{-1}\left(\cos\left(2\tan^{-1}\frac{3}{4}\right) + \sin\left(2\cot^{-1}\frac{1}{2}\right)\right)$ is

(a) $\frac{\pi}{4}$ (b) $\frac{\pi}{3}$ (c) $> \frac{\pi}{4}$ (d) $< \frac{\pi}{4}$

83. Equation of the line through (1, 1, 1) and perpendicular to the plane $2x + 3y - z - 5 = 0$ is

(a) $\frac{x-1}{2} = \frac{y-1}{3} = \frac{z-1}{1}$ (b) $\frac{x-1}{2} = \frac{y-1}{3} = \frac{z-1}{-1}$
(c) $\frac{x-1}{2} = \frac{y-1}{-1} = \frac{z-1}{1}$ (d) None of these

84. If $f(x) = \begin{cases} 3 - x^2, x \le 2 \\ \sqrt{a+14} - |x - 48|, x > 2 \end{cases}$

and $f(x)$ has a local maxima at $x = 2$, then

(a) least value of a is 2011
(b) greatest value of a is 2011
(c) a can't be determined
(d) none of these

85. $\sec^2(\tan^{-1}2) + \text{cosec}^2(\cot^{-1}3)$ is equal to
(a) 1 (b) 5 (c) 10 (d) 15

86. $\int e^x \frac{2-x^2}{(1-x)\sqrt{1-x^2}}dx$ is equal to

(a) $e^x\sqrt{\frac{1-x}{1+x}}\cdot\frac{1}{(1-x)^2}+c$

(b) $e^x\sqrt{\frac{1+x}{1-x}}+c$ (c) $e^x\sqrt{\frac{1-x}{1+x}}+c$

(d) none of these

87. The co-efficient of x^{99} in the polynomial $(x-1)(x-2)(x-3)\ldots\ldots(x-100)$ is
(a) 5050 (b) – 5050
(c) 2525 (d) none of these

88. The value of $\int_0^\infty \frac{\log_e x}{x^2+a^2}dx$ $(a>0)$ is

(a) $\frac{\ln a}{a}$ (b) $\frac{\pi\ln a}{a}$ (c) $\frac{\pi\ln a}{4a}$ (d) $\frac{\pi\ln a}{2a}$

89. If two sides of a triangle are roots of the equation $x^2 - 7x + 8 = 0$ and the angle between these sides is 60°, then the product of inradius and circumradius of the triangle is

(a) $\frac{8}{7}$ (b) $\frac{5}{3}$ (c) $\frac{5\sqrt{2}}{3}$ (d) 8

90. If the first and $(2n-1)^{th}$ terms of an A.P., a G.P. and H.P. are equal and their n^{th} terms are p, q and s respectively, then which of the following options is correct?
(a) $p \geq q \geq s$ (b) $p + s = q$
(c) $ps = q^2$ (d) Both (a) and (c)

SOLUTIONS

1. (b): The given arrangement of nine plates is equivalent to the parallel combination of 8 capacitors. The capacity of each capacitor,

$$C = \frac{\varepsilon_0 A}{d} = \frac{8.854\times10^{-12}\times5\times10^{-4}}{0.885\times10^{-2}}\text{F} = 0.5\text{ pF}$$

The capacity of 8 capacitors = $8C = 8 \times 0.5 = 4$ pF

2. (b): Here, $\beta = 100$, $V_{CE} = 5$ V, $V_{CC} = 10$ V

As $\beta = \frac{I_C}{I_B}$ or $I_B = \frac{I_C}{\beta} = \frac{I_C}{100}$ ...(i)

Also, $V_{CE} = V_{CC} - I_C R_L$

or $5\text{ V} = 10\text{ V} - I_C \times 1000$

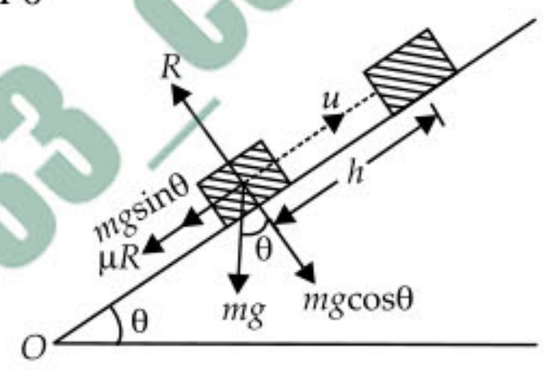
$\therefore \quad I_C = \frac{5\text{ V}}{1000\ \Omega} = 5\times10^{-3}\text{ A}$

and $I_B = \frac{5\times10^{-3}\text{ A}}{100} = 5\times10^{-5}\text{ A}$ (Using (i)

Thus, $R_B = \frac{V_{CC}-V_{BE}}{I_B}$

$= \frac{10\text{ V}}{5\times10^{-5}\text{ A}} = 2\times10^5\ \Omega$ (neglecting V_{BE})

3. (d): Let the distance travelled by the body on the inclined plane be h.
From the free body diagram shown in figure
$R = mg\sin\theta$ ...(i)



Using work energy theorem,
$K = (mg\sin\theta + \mu R)h$ ...(ii)
From (i) and (ii)

$$h = \frac{K}{mg(\sin\theta+\mu\cos\theta)}$$

Work done by friction, $W = \mu Rh$

$$W = \frac{\mu\, mg\cos\theta\, K}{mg\sin\theta + N\cos\theta} = \frac{K\mu\cos\theta}{\sin\theta+\mu\cos\theta}$$

4. (b): Normal to the plane of the coil will be perpendicular to the field $\vec{B}$.
$\therefore \quad \tau = IBA\sin90° = IBA$
Area of equilateral triangle,

$$A = \frac{1}{2}\times\text{Base}\times\text{Height} = \frac{1}{2}\times l\times l\sin60° = \frac{\sqrt{3}}{4}l^2$$

$\therefore \quad \tau = IB\times\frac{\sqrt{3}l^2}{4}$ or $l = 2\left(\frac{\tau}{\sqrt{3}BI}\right)^{1/2}$

5. (c): Since the liquid is in hydrostatic equilibrium,

$\rho_T g h_T = \rho_0 g h_0 \Rightarrow \rho_T = \frac{\rho_0 h_0}{h_T}$

Also, $V_T = V_0(1+\gamma T)$ ...(i)

and $\rho_T V_T = \rho_0 V_0 \Rightarrow \rho_T = \frac{\rho_0}{(1+\gamma T)}$ ...(ii)

From (i) and (ii), we get
$h_T = h_0(1 + \gamma T)$.
which on solving for γ, we get

$$\gamma = \frac{(h_T - h_0)}{h_0 T}$$

6. (b): Since electric field E = – (slope of V-x graph)
and E inside a conductor = 0
$\therefore$ slope of V-x graph between $x = d$ to $x = 2d$ should be zero.
also E in air > E in dielectric
$\therefore$ |Slope in air|>|slope in dielectric|
option (b) satisfies all conditions.

7. (c): The torque on the loop must be equal to the gravitational torque exerted about an axis tangent to the loop.
The gravitational torque

$$\tau_1 = mgr \qquad \ldots(i)$$

Only B_x causes a torque. Therefore torque to the magnetic field

$$\tau_2 = |\vec{M} \times \vec{B}| = MB_x \sin 90° = \pi r^2 I B_x \qquad \ldots(ii)$$

Since, $\tau_1 = \tau_2 \Rightarrow mgr = \pi r^2 I B_x$

$$\therefore \quad I = \frac{mg}{\pi r B_x}$$

8. (d): Since frequency $\upsilon \propto \sqrt{T}$
Where T is tension in sonometer wire

$$\therefore \quad \frac{\upsilon_{air}}{\upsilon_{water}} = \sqrt{\frac{W_{air}}{W_{water}}} = \sqrt{\frac{V\rho g}{V\rho g - V\rho_W g}}$$

$$\text{or} \quad \frac{\upsilon}{\upsilon/2} = \sqrt{\frac{\rho}{\rho - \rho_W}} \quad \text{or} \quad 2 = \sqrt{\frac{\rho}{\rho - \rho_W}}$$

$$\text{or} \quad 4\rho - 4\rho_W = \rho \Rightarrow \rho = \frac{4}{3}\rho_W \qquad \ldots(i)$$

Similarly in second case

$$\frac{\upsilon}{\upsilon/3} = \sqrt{\frac{\rho}{\rho - \rho_L}}$$

$$\text{or} \quad 3 = \sqrt{\frac{\frac{4}{3}\rho_W}{\frac{4}{3}\rho_W - \rho_L}} = \sqrt{\frac{4}{4 - 3\frac{\rho_L}{\rho_W}}}$$

[From equation (i)]

Here specific gravity of the liquid $s = \frac{\rho_L}{\rho_W}$

$$\therefore \quad 9 = \frac{4}{4 - 3s} \Rightarrow 36 - 27s = 4$$

$$\therefore \quad s = \frac{32}{27}$$

9. (d): Here, $\vec{p}(t) = A[\hat{i}\cos(kt) - \hat{j}\sin(kt)]$ …(i)

$$\vec{F} = \frac{d\vec{p}}{dt} = Ak[-\hat{i}\sin(kt) - \hat{j}\cos(kt)] \qquad \ldots(ii)$$

From equation (i) and (ii)

$$\vec{F} \cdot \vec{p} = 0 \text{ or } Fp\cos\theta = 0 \qquad [\because \vec{F}.\vec{p} = Fp\cos\theta]$$

Since $|\vec{F}|$ and $|\vec{p}|$ are not equal to zero.
$\therefore$ $\cos\theta = 0$.
$\therefore$ $\theta = 90°$.

10. (d): In simple harmonic motion,
velocity $v = \omega\sqrt{A^2 - y^2}$

$$\therefore \quad v_1 = \omega\sqrt{A^2 - y_1^2} \Rightarrow v_1^2 = \omega^2 A^2 - \omega^2 y_1^2 \qquad \ldots(i)$$

$$\text{and} \quad v_2 = \omega\sqrt{A^2 - y_2^2} \Rightarrow v_2^2 = \omega^2 A^2 - \omega^2 y_2^2 \qquad \ldots(ii)$$

Solving equations (i) and (ii), we get

$$v_2^2 - v_1^2 = \omega^2(y_1^2 - y_2^2)$$

$$\omega = \sqrt{\frac{v_2^2 - v_1^2}{y_1^2 - y_2^2}}$$

$$\Rightarrow \quad T = \frac{2\pi}{\omega} = 2\pi\sqrt{\frac{y_1^2 - y_2^2}{v_2^2 - v_1^2}}$$

11. (d): Given, $r_0 = 3 \times 10^{-10}$ m and $k = 7$ N m^{-1};
$\because$ $k = Yr_0$

$$\text{or} \quad Y = \frac{k}{r_0} = \frac{7}{3\times10^{-10}} = 2.33\times10^{10} \text{ N m}^{-2}$$

12. (d): Acceleration due to gravity at a place of latitude λ due to the rotation of earth is
$g' = g - R\omega^2\cos^2\lambda$
At equator $\lambda = 0°$, $\cos 0° = 1$
$\therefore$ $g' = g_e = g - R\omega^2$
At poles, $\lambda = 90°$, $\cos 90° = 0$
$\therefore$ $g' = g_p = g$
$\therefore$ $g_p - g_e = g - (g - R\omega^2) = R\omega^2$

13. (a): Here, $u_o = -5$ cm, $f_o = 4$ cm,
$f_e = 10$ cm, $D = 20$ cm
According to lens formula

$$\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_o} \quad \text{or} \quad \frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o}$$

Substituting the given values, we get

$$\frac{1}{v_o} = \frac{1}{4} + \frac{1}{-5} = \frac{1}{4} - \frac{1}{5} = \frac{1}{20}$$

$v_o = 20$ cm

Magnification, $M = \frac{v_o}{|u_o|}\left(1+\frac{D}{f_e}\right)$

$= \frac{20}{5}\left(1+\frac{20}{10}\right) = 12$ cm

14. (c) : Fringe width $\beta = \frac{\lambda D}{d}$ ...(i)

where D is the distance between the screen and slit and d is the distance between two slits.

When a film of thickness t and refractive index μ is placed over one of the slit, the fringe pattern is shifted by distance S and is given by

$S = \frac{(\mu-1)tD}{d}$ ...(ii)

Given, $S = 20\beta$ ...(iii)

From equations (i), (ii) and (iii) we get,

$(\mu - 1)t = 20\lambda$

or $(\mu-1) = \frac{20\lambda}{t} = \frac{20\times5000\times10^{-8}\text{ cm}}{2.5\times10^{-3}\text{ cm}}$

$\mu - 1 = 0.4$ or $\mu = 1.4$

15. (b)

16. (d): $PV = \frac{m}{M}RT$

Initially, $PV = \frac{6}{M}R\times500$ ...(i)

Finally, (if x g gas leaks out)

$\frac{P}{2}V = \frac{(6-x)}{M}R\times300$ ...(ii)

Dividing eqn. (i) by (ii), we get

$2 = \frac{6}{6-x}\times\frac{5}{3}$; $\therefore$ $x = 1$ g

17. (a) : Time taken by each ball to reach highest point,

$t = \frac{1}{n}$ s

As the juggler throws the second ball, when the first ball is at its highest point, so $v = 0$

Using, $v = u + at$, we get

$0 = u + (-g)\left(\frac{1}{n}\right)$ or $u = \left(\frac{g}{n}\right)$ ...(i)

Also $v^2 = u^2 + 2aS$

$\therefore$ $0 = \left(\frac{g}{n}\right)^2 + 2(-g)h$ (Using (i))

$h = \frac{g}{2n^2}$

18. (a) **19. (d)** **20. (b)**

21. (c) : According to radioactive decay, $N = N_0e^{-\lambda t}$ where,

N_0 = Number of radioactive nuclei present in the sample at $t = 0$

N = Number of radioactive nuclei left undecayed after time t

λ = decay constant

For 20% decay

$\frac{80N_0}{100} = N_0e^{-\lambda t_1}$ ...(i)

For 80% decay

$\frac{20N_0}{100} = N_0e^{-\lambda t_2}$ ...(ii)

Dividing equation (i) by (ii), we get

$4 = e^{-\lambda(t_1 - t_2)}$

$\Rightarrow$ $4 = e^{\lambda(t_2 - t_1)}$

Taking natural logarithms of both sides, we get

$\ln 4 = \lambda(t_2 - t_1)$

$2\ln2 = \frac{\ln2}{T_{1/2}}(t_2 - t_1)$

$t_2 - t_1 = 2\times T_{1/2} = 2\times20$ min $= 40$ min

22. (d) : Resistance of coil, $R = \frac{200\text{ V}}{1\text{ A}} = 200\ \Omega$

With ac source, $I = \frac{200}{\sqrt{R^2 + X_L^2}}$ or $0.5 = \frac{200}{\sqrt{R^2 + X_L^2}}$

or $R^2 + (2\pi\upsilon L)^2 = (400)^2$

or $\left(2\pi\upsilon\times\frac{2\sqrt{3}}{\pi}\right)^2 = (400)^2 - (200)^2 = 200\times600$

or $4\sqrt{3}\upsilon = 2\sqrt{3}\times100$ or $\upsilon = 50$ Hz.

23. (c) : Velocity of liquid after falling through a height h is given by

$v^2 = v_0^2 + 2gh$ or $v = \sqrt{(1)^2 + 2(10)(0.15)}$

or $v = 2\text{ m s}^{-1}$

From equation of continuity,

$(10^{-4}\text{ m}^2)(1\text{ m s}^{-1}) = Av$

or $A = \frac{10^{-4}\text{ m}^3\text{ s}^{-1}}{v} = \frac{10^{-4}\text{ m}^3\text{ s}^{-1}}{2\text{ m s}^{-1}} = 5\times10^{-5}\text{ m}^2$

24. (d): As escape velocity, $v = \sqrt{\frac{2GM}{R}}$

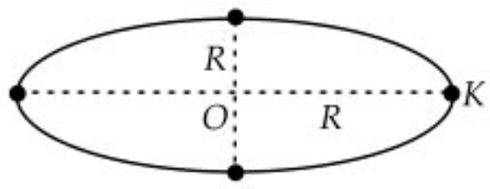
$$v = \sqrt{\frac{2G \times (4\pi/3)R^3\rho}{R}} = \sqrt{(8\pi/3)GR^2\rho},$$

$$\therefore \quad v \propto R\sqrt{\rho}$$

Thus, $\frac{v_e}{v_p} = \frac{R_e\sqrt{\rho_e}}{R_p\sqrt{\rho_p}} = \frac{1}{2}$ [$\because R_p = 2R_e$ and $\rho_e = \rho_p$]

or $v_p = 2v_e = 2 \times 11.2 \text{ km s}^{-1} = 22.4 \text{ km s}^{-1}$

25. (b): According to the theorem of parallel axis, moment of inertia of disc about an axis passing through K and perpendicular to plane of disc as shown in figure



$$= \frac{1}{2}MR^2 + MR^2 = \frac{3}{2}MR^2$$

Total moment of inertia of the system

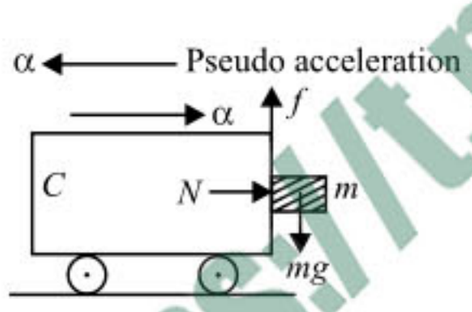
$$= \frac{3}{2}MR^2 + m(2R)^2 + m(\sqrt{2}R)^2 + m(\sqrt{2}R)^2$$

$$= (3M + 16m)\frac{R^2}{2}$$

26. (a): Energy produces = 14.5×10^3 cal min^{-1}.
Amount of sweat evaporated per min

$$= \frac{14.5 \times 10^3 \text{ cal min}^{-1}}{580 \times 10^3 \text{ cal kg}^{-1}} = 0.025 \text{ kg}$$

27. (c):



Pseudo force or fictitious force, $F_{fic} = m\alpha$
From Free body diagram
$N = m\alpha$
Force of friction, $f = \mu N = \mu m\alpha$
The block of mass m will not fall as long as $f \geq mg$

$$\therefore \quad \mu m\alpha \geq mg \text{ or } \alpha \geq \frac{g}{\mu}$$

28. (b): Here, $\lambda_0 = 200$ nm, $\lambda = 100$ nm,

$$\frac{hc}{e} = 1240 \text{ eV nm}$$

$$\text{Maximum kinetic energy} = \frac{hc}{\lambda e} - \frac{hc}{\lambda_0 e} \text{ (in eV)}$$

$$= \frac{hc}{e}\left(\frac{1}{\lambda} - \frac{1}{\lambda_0}\right) = 1240\left(\frac{1}{100} - \frac{1}{200}\right) = 6.2 \text{ eV}$$

29. (c): Let $G = kc^x g^y P^z$

$$[M^{-1}L^3T^{-2}] = [LT^{-1}]^x[LT^{-2}]^y[ML^{-1}T^{-2}]^z$$
$$= [M^zL^{x+y-z}T^{-x-2y-2z}]$$

Equating both sides, we get,
$z = -1, x + y - z = 3, -x - 2y - 2z = -2$
On solving, $x = 0$ $y = 2$, $z = -1$.
Thus, $[G] = [c^0g^2P^{-1}]$

30. (a): $f_s = \mu_s R$ and $f_k = \mu_k R$
When the body is in motion, net force acting on the body,
i.e., $F = f_s - f_k = \mu_s R - \mu_k R$

or $a = \frac{F}{m} = \frac{(\mu_s - \mu_k)mg}{m}$ ($\because R = mg$)

$= (\mu_s - \mu_k)g$
$= (0.5 - 0.4) \times 9.8 = 0.98 \text{ m s}^{-2}$.

31. (a): Smaller the size of cation, larger is the degree of hydration, hence, larger is the stability of hydrated ion.

32. (a): More the number of electron withdrawing groups, more the nucleophilic addition reaction will be favoured. Aldehydes are more reactive than ketones. Therefore, (IV) > (III) > (II) > (I).

33. (c): Number of O-atoms per unit cell

$$= \frac{1}{8} \times 8 + \frac{1}{2} \times 6 = 4$$

Number of octahedral holes per unit cell
$= 1 \times 4 = 4$

Number of Fe^{3+} ions per unit cell = $\frac{50 \times 4}{100} = 2$

Number of tetrahedral voids per unit cell
$= 2 \times 4 = 8$

Number of Zn^{2+} ions per unit cell = $\frac{1}{8} \times 8 = 1$

Hence, formula of the compound is $ZnFe_2O_4$.

34. (c): 80 mL of 0.20 M HCl = $80 \times 0.2 = 16$ millimoles
120 mL of 0.15 M KOH = $120 \times 0.15 = 18$ millimoles
As, $\underset{(HCl)}{M_1V_1} < \underset{(KOH)}{M_2V_2}$
Thus, resulting solution is basic, containing KCl and unreacted KOH,

$$KOH + HCl \rightarrow KCl + H_2O$$

$$[KOH]_{unreacted} = \frac{M_2V_2 - M_1V_1}{V_1 + V_2} = \frac{18 - 16}{200} = 0.01 \text{ M}$$

KCl formed = HCl used = 16 millimoles
$= 16 \times 10^{-3}$ mol in 200 mL or 0.2 L solution

$$\therefore \quad [KCl] = \frac{16 \times 10^{-3}}{0.2 \text{ L}} = 0.08 \text{ M}$$

35. (b)

36. (c) : Extensive properties are the properties which depend upon the quantity of the matter contained in the system, *e.g.*, mass, volume, Gibbs free energy, etc. Intensive properties are the properties which depend only upon the nature of the substance and are independent of the amount of the substance present in the system, *e.g.*, heat, boiling point, emf of a cell, etc.

37. (b) : We know that, $\frac{r_A}{r_B}=\frac{V/t_A}{V/t_B}=\sqrt{\frac{M_B}{M_A}}$

$$\frac{t_B}{t_A}=\sqrt{\frac{M_B}{M_A}} \Rightarrow \frac{10}{20}=\sqrt{\frac{M_B}{49}} \Rightarrow \left(\frac{10}{20}\right)^2=\frac{M_B}{49}$$

$$\Rightarrow \frac{100}{400}=\frac{M_B}{49} \Rightarrow M_B=\frac{49\times100}{400}=12.25\text{ u}$$

38. (b) : Coordination number of Pt is 6. Hence

(i) $K_2[PtCl_6]$ – Three ions
(ii) $[Pt(NH_3)_2Cl_4]$ – Zero ions
(iii) $[Pt(NH_3)_3Cl_3]Cl$ – Two ions
(iv) $[Pt(NH_3)_5Cl]Cl_3$ – Four ions

$\therefore$ $[Pt(NH_3)_2Cl_4]$ has least electrical conductance.

39. (c) : Difference in mass of compounds = 390 – 180 = 210

Weight of CH_3CO — group = 43
Replacement of —H by —$COCH_3$ group will cause increase of 42 in mass.

Therefore, no. of —NH_2 groups = $\frac{210}{42}=5$

40. (b) :

	$NH_4Cl_{(s)}$	$\rightleftharpoons$	$NH_{3(g)}$	+	$HCl_{(g)}$
moles at $t=0$	0.20		0		0
moles at eq.	$(0.20-a)$		a		a

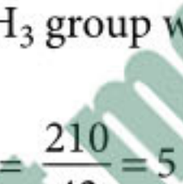
Also, $K_p=p_{NH_3}\times p_{HCl}=p^2$

$p=\sqrt{K_p}=\sqrt{0.36}=0.6$ atm

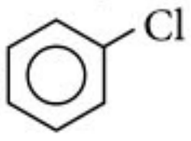
Now, moles of NH_3 formed, $n=\frac{PV}{RT}=\frac{0.6\times10}{0.0821\times600}$

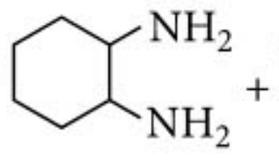
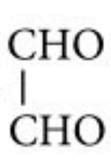
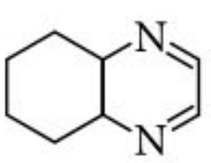
= 0.122 mole = moles of NH_4Cl decomposed

$\therefore$ NH_4Cl left = 0.2 – 0.122 = 0.078 mole

41. (d) : (a) $Me-C\equiv CH \xrightarrow[\text{Fe tube}]{\text{Red hot}}$ 

(b) $C_6H_{14} \xrightarrow[Cr_2O_3,\,\Delta]{Al_2O_3}$ 

(c)  $\xrightarrow[KOH]{CHCl_3}$ 

(d)  +  $\longrightarrow$ 

(not aromatic)

42. (c) : K_{sp} of $MOH = 1\times10^{-10}$

$[M^+][OH^-]=1\times10^{-10}$

Now, $[M^+]=[OH^-]$

$\therefore$ $[OH^-]^2=1\times10^{-10}$ or $[OH^-]=10^{-5}$

$$[H_3O^+]=\frac{10^{-14}}{10^{-5}}=10^{-9}$$

$pH=-\log(10^{-9})=9$

43. (a)

44. (a) : As we move from left to right in a period the basic character of oxides of *s*- and *p*-block elements decreases while their acidic character increases. The basic character of oxides of *d*-block elements is, lower than alkali and alkaline earth metals. Thus, Na_2O is most basic followed by MgO and Al_2O_3 while CuO is least basic.

45. (a) : Balanced redox reaction for oxidation of ferrous ion to ferric ion is

$MnO_4^- + 5Fe^{2+} + 8H^+ \longrightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

1 mole $KMnO_4 \equiv$ 5 moles $FeSO_4$

Number of moles of $KMnO_4$ used = $\frac{MV}{1000}$

$=\frac{0.02\times12}{1000}=2.4\times10^{-4}$ M

$\therefore$ Number of moles of $FeSO_4$ in 50 mL solution
$=5\times2.4\times10^{-4}=12.0\times10^{-4}$

Thus, molarity of $FeSO_4=\frac{n}{V}\times1000$

$=\frac{12\times10^{-4}}{50}\times1000=0.024$ M

46. (c) : m^{th} line, $\frac{1}{\lambda}=R_H\cdot Z^2\left[\frac{1}{2^2}-\frac{1}{(m+2)^2}\right]$;

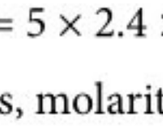
ΔE of two successive orbits becomes almost constant after a certain value of *n*.

Number of lines = $\Sigma\Delta n=\Sigma(5-2)=\Sigma3=6$

47. (c) : According to Gibbs' equation,

$\Delta G=\Delta H-T\Delta S$

Since, ΔH and ΔS, both are +ve, for $\Delta G<0$, the value of $T>T_e$.

48. (c) :  $\xrightarrow[KOH]{\text{Alc.}}$ $CH_3-CH=CH_2$ (*A*)

$\xrightarrow[475\text{ K}]{SO_2Cl_2}$ $\overset{3}{C}H_3-\overset{2}{C}H=\overset{1}{C}H-Cl$

1-Chloropropene (*B*)

49. (c) : $NaHSO_3$ reacts with acetone to form sodium, bisulphite adduct product and precipitate, but CCl_4 remains in the solution. The acetone can be regenerated from sodium bisulphite adduct by treating it with an acid or a base.

50. (a) : $2Al + Na_2CO_3 + 3H_2O \rightarrow 2NaAlO_2 + CO_2 + 3H_2$

$NaAlO_2$ is sodium aluminate which is soluble in water.

51. (b) : $k = \frac{2.303}{t}\log\frac{[A]_0}{[A]_t} = \frac{2.303}{1.0}\log\frac{100}{30}$

Again, $k = \frac{2.303}{2.5}\log\frac{100}{x}$

Hence, $\frac{2.303}{1.0}\log\frac{100}{30} = \frac{2.303}{2.5}\log\frac{100}{x}$

$\log\frac{100}{x} = 2.5\log\frac{100}{30}$

$\log\frac{100}{x} = 2.5\,(\log 100 - \log 30)$

$= 2.5 \times 0.5229 = 1.307$

$\frac{100}{x} = \text{antilog } 1.307$ or $\frac{100}{x} = 20.28$

or $x = \frac{100}{20.28} = 4.93\,\% \approx 5\%$

52. (c)

53. (a) : $k = \frac{k_1 k_2}{k_3}$

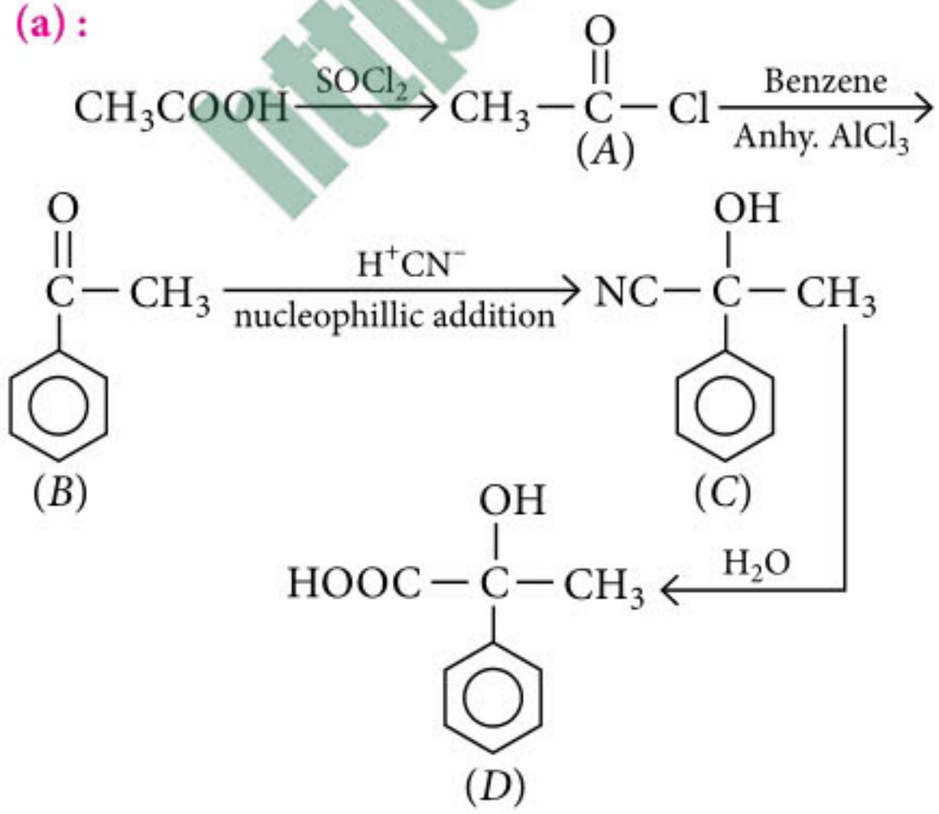
$Ae^{-E/RT} = \frac{Ae^{-E_1/RT}Ae^{-E_2/RT}}{Ae^{-E_3/RT}}$

$e^{-E/RT} = e^{(-E_1-E_2+E_3)/RT}$

$-\frac{E}{RT} = \frac{-E_1 - E_2 + E_3}{RT}$

$E = E_1 + E_2 - E_3 = 40 + 50 - 60 = 30\ \text{kJ mol}^{-1}$

54. (a) :



55. (a) : $\because\ \pi = \frac{w}{MV}RT$

$= \left[\left(\frac{w}{M}\right)_{\text{urea}} + \left(\frac{w}{M}\right)_{\text{glucose}}\right] \times \frac{RT}{V}$

Now, w_{urea} in 20 mL $= \frac{2\times 20}{100} = 0.4$ g

w_{glucose} in 80 mL $= \frac{4\times 80}{100} = 3.2$ g

$\therefore\ \pi = \left[\frac{0.4}{60} + \frac{3.2}{180}\right] \times \frac{0.0821\times 300\times 1000}{100}$

$\left(\because\ V = 20 + 80 = 100\ \text{mL} = \frac{100}{1000}\ \text{L}\right)$

$\pi = 6.02$ atm

56. (c)

57. (d) : More the number of electron withdrawing $-NO_2$ group at *o*- and *p*-position *w.r.t.* the Cl atom, more reactive is the compound. Thus, the correct order is III > II > I.

58. (c) : As_2S_3 sol is negatively charged owing to preferential adsorption of S^{2-} ions. Cation would be effective in causing coagulation.

Flocculating value = minimum millimoles of the effective ion per litre of sol $= \frac{4\times 0.005}{(4+16)\times 10^{-3}} = 1.0$

59. (b) : Silver ore is oxidised by using oxygen from air as follows :

$4Ag + 8NaCN + 2H_2O + O_2(\text{air}) \longrightarrow 4Na[Ag(CN)_2] + 4NaOH$

Sodium argentocyanide

$Ag(0) \xrightarrow{\text{oxidation}} Ag(+1)$

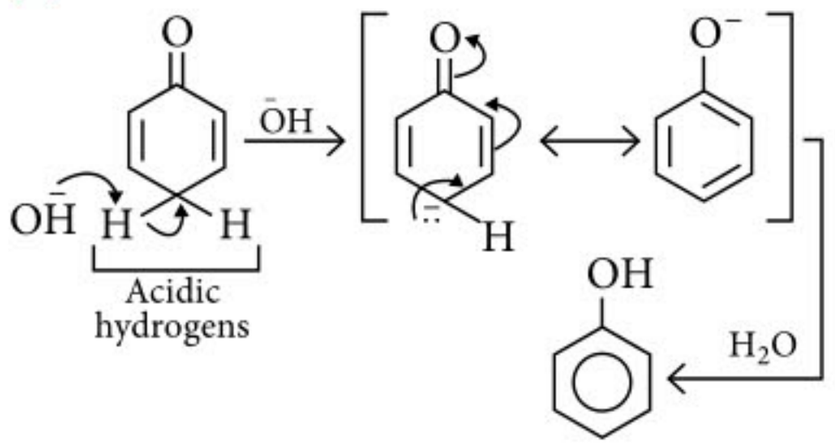
Silver is precipitated from the solution by addition of Zn powder in a finely divided condition.

$2Na[Ag(CN)_2] + Zn \longrightarrow Na_2[Zn(CN)_4] + 2Ag$

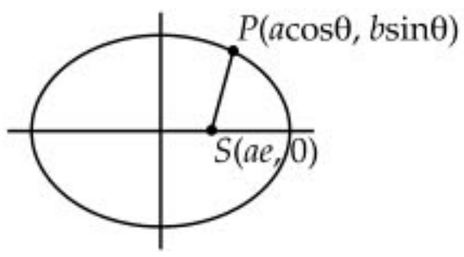
Sodium zinc cyanide

$Ag(+1) \xrightarrow{\text{reduction}} Ag(0)$

60. (b) :



61. (d): Let $\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$ be an ellipse. Its focus is $(ae, 0)$ and area $=\pi ab$. Let (h, k) be the mid-point of PS.



$\therefore \quad h=\frac{a\cos\theta+ae}{2}$

$\Rightarrow \quad \cos\theta=\frac{2h-ae}{a}$ and $k=\frac{b\sin\theta}{2} \Rightarrow \sin\theta=\frac{2k}{b}$.

$\therefore \quad \frac{(2h-ae)^2}{a^2}+\frac{4k^2}{b^2}=1 \Rightarrow \frac{4\left(h-\frac{ae}{2}\right)^2}{a^2}+\frac{4k^2}{b^2}=1$

$\Rightarrow \quad \frac{\left(h-\frac{ae}{2}\right)^2}{\left(\frac{a}{2}\right)^2}+\frac{k^2}{\left(\frac{b}{2}\right)^2}=1$

This is also an ellipse whose area $=\pi\frac{a}{2}.\frac{b}{2}=\frac{\pi ab}{4}$

$\therefore$ Required ratio $=\frac{1}{4}$

62. (a): $X_n=\left\{z=x+iy:|z|^2\le\frac{1}{n}\right\}, \forall\, n\ge 1$

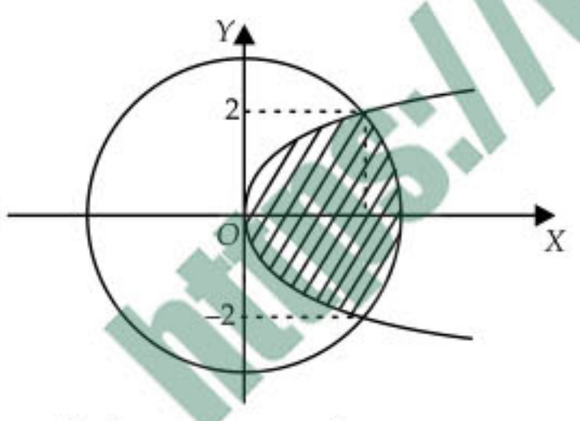
Now, $|z|^2\le\frac{1}{n} \Rightarrow x^2+y^2\le\frac{1}{n}$

$\Rightarrow x^2+y^2\le 0$, when $n\to\infty$

The above inequation is true only when $x=0, y=0$

So $\bigcap_{n=1}^{\infty} X_n$ will be a point circle which is a singleton set.

63. (d):



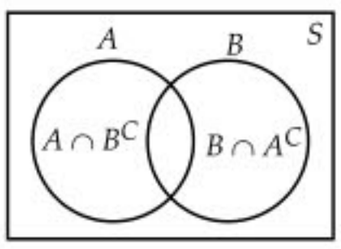
$\text{Area}=\int_{-2}^{2}\left(\sqrt{5-y^2}-\frac{y^2}{4}\right)dy$

$=2\int_{0}^{2}\left(\sqrt{5-y^2}-\frac{y^2}{4}\right)dy=2\left(\frac{1}{3}+\frac{5}{2}\sin^{-1}\left(\frac{2}{\sqrt{5}}\right)\right)$

64. (c): Given that $P(A\cap B^C)=\frac{3}{25}$ and $P(A^C\cap B)=\frac{8}{25}$, $P(A)>\frac{1}{2}$

Let $P(A)=x$, $P(B)=y$

$P(A\cap B^C)=P(A)-P(A\cap B)$



$\Rightarrow \quad \frac{3}{25}=x-P(A)P(B)$ [$\because$ A and B are independent]

$\frac{3}{25}=x-xy$

Also, $P(A^C\cap B)=P(B)-P(A\cap B)$

$\Rightarrow \quad \frac{8}{25}=y-xy.$ Hence $y=x+\frac{1}{5}$

$\therefore$ Solving x and y we get $x=\frac{1}{5}$, $y=\frac{2}{5}$

or $x=\frac{3}{5}$ and $y=\frac{4}{5}$

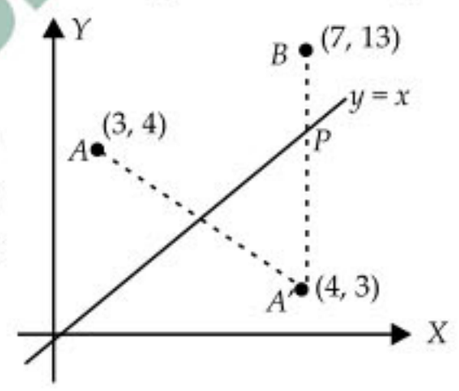
As $P(A)>\frac{1}{2}$, we must have $P(A)=\frac{3}{5}$ and $P(B)=\frac{4}{5}$

$\therefore \quad P(A)+P(B)=\frac{7}{5}$

65. (c): Consider a point A', the image of A through $y=x$

$\therefore$ Coordinates of $A'=(4, 3)$

[Notice that A and B lie to the same side with respect to $y=x$].



Then $PA=PA'$.

Thus, $PA+PB$ is minimum, if $PA'+PB$ is minimum, if P, A', B are collinerar.

Now,

$A'B$ is $y-3=\frac{13-3}{7-4}(x-4) \Rightarrow 3y-10x+31=0$

It intersects $y=x$ at $\left(\frac{31}{7}, \frac{31}{7}\right)$, which is the required point P.

66. (b): Let $\vec{r}=x\hat{i}+y\hat{j}+z\hat{k}$. Then,

$\hat{i}\times(\vec{r}\times\hat{i})+\hat{j}\times(\vec{r}\times\hat{j})+\hat{k}\times(\vec{r}\times\hat{k})$

$=(\hat{i}\cdot\hat{i})\vec{r}-(\hat{i}\cdot\vec{r})\hat{i}+(\hat{j}\cdot\hat{j})\vec{r}-(\hat{j}\cdot\vec{r})\hat{j}+(\hat{k}\cdot\hat{k})\vec{r}-(\hat{k}\cdot\vec{r})\hat{k}$

$=\vec{r}-x\hat{i}+\vec{r}-y\hat{j}+\vec{r}-z\hat{k}$

$=3\vec{r}-(x\hat{i}+y\hat{j}+z\hat{k})=3\vec{r}-\vec{r}=2\vec{r}$

67. (a): $|r_1-r_2|<C_1C_2<r_1+r_2$

$\Rightarrow |r-3|<5<r+3$

$\Rightarrow 5<r+3 \Rightarrow 2<r$ ...(i)

Also, $|r-3|<5$

$\Rightarrow -5<r-3<5$

$\Rightarrow -2<r<8$ ...(ii)

From (i) & (ii) we get, $2<r<8$

68. (a): Let $f(1)=a$

Then, $f(x)+a+2xf(x)=\frac{f(x)}{f(x+1)}$

$\Rightarrow \quad f(x+1)=\frac{f(x)}{(1+2x)f(x)+a}$

Hence $f(2)=\frac{1}{4}; f(3)=\frac{1}{5+4a}; f(4)=\frac{1}{7+5a+4a^2}$

Put $x=y=2$, then $2f(2)+8f(4)=\frac{f(y)}{f(y)}=1$

So, $\frac{1}{2}+\frac{8}{7+5a+4a^2}=1 \Rightarrow a=1$

69. (a) : Let $f(x) = ax^2 + bx + c$

Then, $f(1) = a + b + c$

and $f(-1) = a - b + c$

Since, $f(1) = f(-1)$

$\Rightarrow a + b + c = a - b + c \Rightarrow 2b = 0 \Rightarrow b = 0$

i.e., $f(x) = ax^2 + c$

$\therefore\ f'(x) = 2ax$

$f'(a) = 2a^2, f'(b) = 2ab, f'(c) = 2ac$

Now, $2f'(b) = f'(a) + f'(c)$

If $2.2ab = 2a^2 + 2ac$

If $2b = a + c$

If a, b, c are in A.P., which is given.

$\therefore\ f'(a), f'(b), f'(c)$ are in A.P.

70. (b) : $\begin{vmatrix} x+1 & x+2 & x+a \\ x+2 & x+3 & x+b \\ x+3 & x+4 & x+c \end{vmatrix} = 0$

Applying $C_1 \to C_1 - C_2$ and $C_2 \to C_2 - C_3$, we get

$\begin{vmatrix} -1 & 2-a & x+a \\ -1 & 3-b & x+b \\ -1 & 4-c & x+c \end{vmatrix} = 0$

Applying $R_1 = R_1 - R_2$ and $R_2 = R_2 - R_3$, we get

$\Rightarrow \begin{vmatrix} 0 & b-a-1 & a-b \\ 0 & c-b-1 & b-c \\ -1 & 4-c & x+c \end{vmatrix} = 0$

$\Rightarrow -1[(b-a-1)(b-c)-(c-b-1)(a-b)] = 0$

$\Rightarrow -[(b-a)(b-c)-(b-c)+(b-a)(c-b)-(b-a)] = 0$

$\Rightarrow -[-b+c-b+a] = 0$

$\Rightarrow 2b = a + c \ \therefore\ a, b, c$ are in A.P.

71. (c) : $\frac{C_0}{1}+\frac{C_1}{2}+\frac{C_2}{3}+.....+\frac{C_n}{n+1}$

$=\frac{1}{n+1}\left[(n+1)C_0+\frac{(n+1)C_1}{2}+\frac{(n+1)C_2}{3}+.....+C_n\right]$

$=\frac{1}{n+1}\left[\left\{1+(n+1)+\frac{(n+1)n}{2}+\frac{(n+1)n(n-1)}{2!3}+..+1\right\}-1\right]$

$=\frac{1}{n+1}\left[\left\{1+(n+1)+\frac{(n+1)n}{2!}+\frac{(n+1)n(n-1)}{3!}+.....+1\right\}-1\right]$

$=\frac{1}{n+1}\left[(1+1)^{n+1}-1\right]=\frac{2^{n+1}-1}{n+1}.$

72. (c) : $f(x) = x^3 + x^2 + 100x + 5\sin x$

$f'(x) = 3x^2 + 2x + 100 + 5\cos x$

$=3x^2 + 2x + 94 + (6 + 5\cos x) > 0$

$\therefore\ f(x)$ is an increasing function and consequently a one-one function.

Clearly $f(-\infty) = -\infty, f(\infty) = \infty$ and $f(x)$ is continuous,

$\therefore$ range $f = R =$ codomain.

Hence, f is onto

73. (b) : By Lagrange's identity, we have

$(\vec{a}\times\vec{b})^2 = |\vec{a}|^2|\vec{b}|^2 - (\vec{a}\cdot\vec{b})^2$

$\Rightarrow |\vec{a}\times\vec{b}|^2 = |\vec{a}|^2|\vec{b}|^2 - (\vec{a}\cdot\vec{b})^2 = 16-4=12$

Again $|\vec{c}|^2 = (2\vec{a}\times\vec{b}-3\vec{b})(2\vec{a}\times\vec{b}-3\vec{b})$

$= 4(\vec{a}\times\vec{b})^2 - 6\vec{b}(\vec{a}\times\vec{b}) - 6\vec{b}(\vec{a}\times\vec{b}) + 9|\vec{b}|^2$

$= 4|\vec{a}\times\vec{b}|^2 + 9|\vec{b}|^2 = (4\times 12) + (9\times 16)$

$\Rightarrow |\vec{c}|^2 = 192 \ \therefore\ |\vec{c}| = \sqrt{192} = 8\sqrt{3}$

Now, $\vec{b}\cdot\vec{c} = \vec{b}\cdot(2\vec{a}\times\vec{b}-3\vec{b}) = 0 - 3\vec{b}^2$

$= -3|\vec{b}|^2 = -3\times 16 \Rightarrow \vec{b}\cdot\vec{c} = -48$

Let the angle between $\vec{b}$ and $\vec{c}$ be θ.

$\therefore\ \cos\theta = \frac{\vec{b}\,.\,\vec{c}}{|\vec{b}||\vec{c}|} = \frac{-48}{4\times 8\sqrt{3}} = -\frac{\sqrt{3}}{2}$

$= \cos(180° - 30°) = \cos 150°$

$\therefore\ \cos\theta = \cos\frac{5\pi}{6} \Rightarrow \theta = \frac{5\pi}{6}.$

74. (b) : $|B| = -\begin{vmatrix} q & -b & y \\ p & -a & x \\ r & -c & z \end{vmatrix} = \begin{vmatrix} q & b & y \\ p & a & x \\ r & c & z \end{vmatrix}$

$= -\begin{vmatrix} p & a & x \\ q & b & y \\ r & c & z \end{vmatrix} = \begin{vmatrix} a & p & x \\ b & q & y \\ c & r & z \end{vmatrix} = \begin{vmatrix} a & b & c \\ p & q & r \\ x & y & z \end{vmatrix}$

$= -\begin{vmatrix} a & b & c \\ x & y & z \\ p & q & r \end{vmatrix} \Rightarrow |B| = -|A|$

75. (b) : $\tan x = t \Rightarrow \frac{4t^2}{1+t^2} + t^2 + \frac{2}{t^2} = 5$

$\Rightarrow (t^2-1)(t^4+t^2-2) = 0 \Rightarrow t^2 = 1, -2$

$\Rightarrow x = \frac{\pi}{4}, \frac{3\pi}{4}.$

76. (d) : $P(1, 2),\ PQ = \frac{\sqrt{6}}{3}$

$\because\ \frac{x-x_1}{a} = \frac{y-y_1}{b} = \frac{-(ax_1+by_1+c)}{a^2+b^2}$

$\therefore \quad \frac{x-1}{1}=\frac{y-2}{1}=\frac{-(1+2-4)}{1^2+1^2}=\frac{1}{2}$

$\Rightarrow \quad \frac{x-1}{1}=\frac{y-2}{1}=\frac{-(1+2-4)}{1^2+1^2}=\frac{1}{2}$

$\Rightarrow \quad x=\frac{3}{2}, y=\frac{5}{2}$

Using $\frac{x-x_1}{\cos\theta}=\frac{y-y_1}{\sin\theta}=\pm r$, $\frac{x-1}{\cos\theta}=\frac{y-2}{\sin\theta}=\pm\frac{\sqrt{6}}{3}$

$x = 1 + r\cos\theta, \quad y = 2 + r\sin\theta$

Using $x + y = 4$, $(1 + r\cos\theta) + (2 + r\sin\theta) = 4$,

$r(\cos\theta + \sin\theta) = 1$, we get

$r=\frac{\sqrt{6}}{3}=\frac{\sqrt{3}.\sqrt{2}}{\sqrt{3}\sqrt{3}}=\sqrt{\frac{2}{3}}$

$\sqrt{\frac{2}{3}}(\cos\theta+\sin\theta)=1,\ \cos\theta+\sin\theta=\sqrt{\frac{3}{2}}$

$\frac{1}{\sqrt{2}}\cos\theta+\frac{1}{\sqrt{2}}\sin\theta=\frac{\sqrt{3}}{2}$

$\cos(\theta - 45°) = \cos30° = \sin30°$

$\Rightarrow \ \theta - 45° = 30° \ \Rightarrow \ \theta = 75°$

77. (c) : $\lim_{n\to\infty}\left[\frac{2n}{2n^2-1}\cos\frac{n+1}{2n-1}-\frac{n}{1-2n}\cdot\frac{n(-1)^n}{n^2+1}\right]$

$=\lim_{n\to\infty}\left[\frac{2}{2-\frac{1}{n^2}}\cdot\frac{1}{n}\cos\left(\frac{1+\frac{1}{n}}{2-\frac{1}{n}}\right)-\frac{1}{\left(\frac{1}{n}-2\right)}\cdot\frac{(-1)^n}{\left(1+\frac{1}{n^2}\right)}\cdot\frac{1}{n}\right]$

$=\lim_{n\to\infty}\frac{1}{n}\left[\frac{2}{2-\frac{1}{n^2}}\cdot\cos\left(\frac{1+\frac{1}{n}}{2-\frac{1}{n}}\right)-\frac{1}{\left(\frac{1}{n}-2\right)}\cdot\frac{(-1)^n}{\left(1+\frac{1}{n^2}\right)}\right]$

$=0\times\left[\frac{2}{2}\times\cos\frac{1}{2}+\frac{1}{2}\times\frac{1}{1}\right]=0$

78. (c) : For $|x| < 1$, $x^{2n} \to 0$ as $n \to \infty$

$|x|>1, \frac{1}{x^{2n}}\to 0$ as $n\to\infty$

$$f(x)=\begin{cases}\log_e(2+x), & |x|<1\\ \lim\limits_{n\to\infty}\dfrac{x^{-2n}\log_e(2+x)-\sin x}{x^{-2n}+1}=-\sin x, \text{if } |x|>1\\ \dfrac{1}{2}\left(\log_e(2+x)-\sin x\right), & |x|=1\end{cases}$$

$\lim_{x\to1^+} f(x)=-\sin1; \quad \lim_{x\to1^-} f(x)=\log3.$

79. (b) : The equation of a line which passes through $(-2, -1)$ is $y + 1 = m(x + 2)$ ...(i)

The equation (i) will touches the circle $x^2 + y^2 = 1$ if

$\left|\frac{2m-1}{\sqrt{1+m^2}}\right|=1 \Rightarrow m=0,\frac{4}{3}$

$\therefore$ (i) becomes $y+1=\frac{4}{3}(x+2)$

$\Rightarrow 4x - 3y + 5 = 0$

Now $(-5, -5)$ is a point on the above line. Its image by the line $y = -1$ is $(-5, 3)$.

$\therefore$ The equation of the incident ray is

$\frac{y+1}{-1-3}=\frac{x+2}{-2+5} \Rightarrow 4x+3y+11=0$

80. (d) : Put $x = 2\sec\theta$

$\Rightarrow dx = 2\sec\theta\tan\theta\, d\theta$

$\therefore \quad I=\int_0^{\pi/3}\frac{2\tan\theta.(2\sec\theta\tan\theta)d\theta}{4\sec^2\theta}$

$=\int_0^{\pi/3}\frac{\sin^2\theta d\theta}{\cos\theta}=\int_0^{\pi/3}\frac{1-\cos^2\theta}{\cos\theta}d\theta$

$\int_0^{\pi/3}(\sec\theta-\cos\theta)d\theta=\left[\log|\sec\theta+\tan\theta|\right]_0^{\pi/3}-\left[\sin\theta\right]_0^{\pi/3}$

$=\log\left(2+\sqrt{3}\right)-\frac{\sqrt{3}}{2} \quad \therefore \quad \alpha=2+\sqrt{3}, \beta=-\frac{\sqrt{3}}{2}$

$\therefore$ (a) $\alpha + 2\beta = 2$, which is rational.

(b) $\alpha = 2(1 - \beta)$

(c) $(\alpha - 2)^2 = (-2\beta)^2 \ \Rightarrow \ \alpha^2 - 4\alpha + 4 = 4\beta^2$

$\Rightarrow \alpha^2-4\beta^2=4(\alpha-1) \Rightarrow (\alpha,\beta)$ lies on $x^2-4y^2=4(x-1)$

Hence, (d) is correct.

81. (a) : As α, β are the roots of the equation $ax^2 + 2bx + c = 0$ $\therefore \alpha+\beta=-\frac{2b}{a}, \alpha\beta=$ and γ, δ are the roots of the equation $px^2 + 2qx + r = 0$

$\therefore \quad \gamma+\delta=-\frac{2q}{p}$ and $\gamma\delta=\frac{r}{p}$.

Again α, β, γ, δ are in A.P. $\therefore \ \beta - \alpha = \delta - \gamma$

or, $(\alpha - \beta)^2 = (\gamma - \delta)^2$ or, $(\alpha + \beta)^2 - 4\alpha\beta$

$= (\gamma + \delta)^2 - 4\gamma\delta$

or, $\frac{4b^2}{a^2}-\frac{4c}{a}=\frac{4q^2}{p^2}-\frac{4r}{p}$ or $\frac{4b^2-4ac}{a^2}=\frac{4q^2-4pr}{p^2}$

or $\frac{b^2-ac}{q^2-pr}=\frac{a^2}{p^2}$

82. (c) : $\sin\left(2\cot^{-1}\frac{1}{2}\right)=\frac{4}{5}, \cos\left(2\tan^{-1}\frac{3}{4}\right)=\frac{7}{25}$

83. (b) : Equation of the line passing through the point $(1, 1, 1)$ is $\frac{x-1}{a}=\frac{y-1}{b}=\frac{z-1}{c}$ ...(i)

Since the line (i) is perpendicular to the plane $2x + 3y - z = 5$ $\therefore$ direction ratios of the normal to the plane are 2, 3, and – 1 $\therefore$ (i) becomes $\frac{x-1}{2}=\frac{y-1}{3}=\frac{z-1}{-1}$, which is the required line.

84. (b): Local maxima at $x = 2$

$\Rightarrow \lim_{h\to 0} f(2+h) \le f(2)$

$\Rightarrow \lim_{h\to 0} \left(\sqrt{a+14} - |2+h-48|\right) \le (3-2^2)$

$\Rightarrow \sqrt{a+14} \le 45 \Rightarrow a \le 2011$

$\therefore$ Greatest value of $a = 2011$

85. (d): The given expression is equal to

$1 + [\tan(\tan^{-1} 2)]^2 + 1 + [\cot(\cot^{-1} 3)]^2$

$= 1 + 4 + 1 + 9 = 15$

86. (b): $\int e^x \frac{2-x^2}{(1-x)\sqrt{1-x^2}}dx = \int e^x \frac{1+(1-x^2)}{(1-x)\sqrt{1-x^2}}dx$

$= \int e^x \left[\frac{1}{(1-x)\sqrt{1-x^2}} + \frac{1+x}{\sqrt{1-x^2}}\right]dx$

$= \int e^x \left[\frac{1}{(1-x)^{3/2}\sqrt{1+x}} + \sqrt{\frac{1+x}{1-x}}\right]dx$

$= \int e^x \left[\sqrt{\frac{1-x}{1+x}}\cdot\frac{1}{(1-x)^2} + \sqrt{\frac{1+x}{1-x}}\right]dx$

$= \int e^x \sqrt{\frac{1+x}{1-x}}dx + \int e^x \sqrt{\frac{1-x}{1+x}}\cdot\frac{1}{(1-x)^2}dx$

$= \sqrt{\frac{1+x}{1-x}}\cdot e^x - \int e^x \sqrt{\frac{1-x}{1+x}}\cdot\frac{1}{(1-x)^2}dx + \int e^x \sqrt{\frac{1-x}{1+x}}\cdot\frac{1}{(1-x)^2}dx + c$

$= e^x \sqrt{\frac{1+x}{1-x}} + c$

87. (b): $(x - 1)(x - 2)(x - 3) \ldots\ldots (x - 100)$

$= x^{100} - (1 + 2 + 3 + \ldots\ldots + 100)\, x^{99} + \ldots\ldots$

$\therefore$ The co-efficient of x^{99} is $-(1 + 2 + 3 + \ldots\ldots + 100)$

$= -\frac{100(100+1)}{2} = -101 \times 50 = -5050$

88. (d): $\int_0^\infty \frac{\log_e x}{x^2+a^2}dx = \underbrace{\int_0^a \frac{\ln x}{a^2+x^2}dx}_{I_1} + \underbrace{\int_a^\infty \frac{\ln x}{a^2+x^2}dx}_{I_2}$

Now substitute $x = \frac{a^2}{y}$ in I_2

$I_2 = -\int_a^0 \frac{2\ln a - \ln y}{a^2+y^2}dy$

$\therefore I = I_1 + I_2 = 2\ln a \int_0^a \frac{dx}{a^2+x^2} = 2\ln a\left[\frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)\right]_0^a = \frac{\pi \ln a}{2a}$

89. (b): Let a and b be the roots of $x^2 - 7x + 8 = 0$. Then $a + b = 7$, $ab = 8$. Also $\angle C = 60°$

Now, $\frac{1}{2} = \frac{a^2+b^2-c^2}{2ab} \Rightarrow ab = (a+b)^2 - 2ab - c^2$

$\therefore c^2 = (a+b)^2 - 3ab = 49 - 24 = 25 \Rightarrow c = 5$

Thus $r \cdot R = \frac{abc}{2(a+b+c)} = \frac{8\times 5}{2(7+5)} = \frac{5}{3}$

90. (d): Let the first term be a and $(2n - 1)^{th}$ term be b then

$\Rightarrow p = a + (n-1)d = a + (n-1)\left(\frac{b-a}{2n-2}\right) = \frac{a+b}{2}$

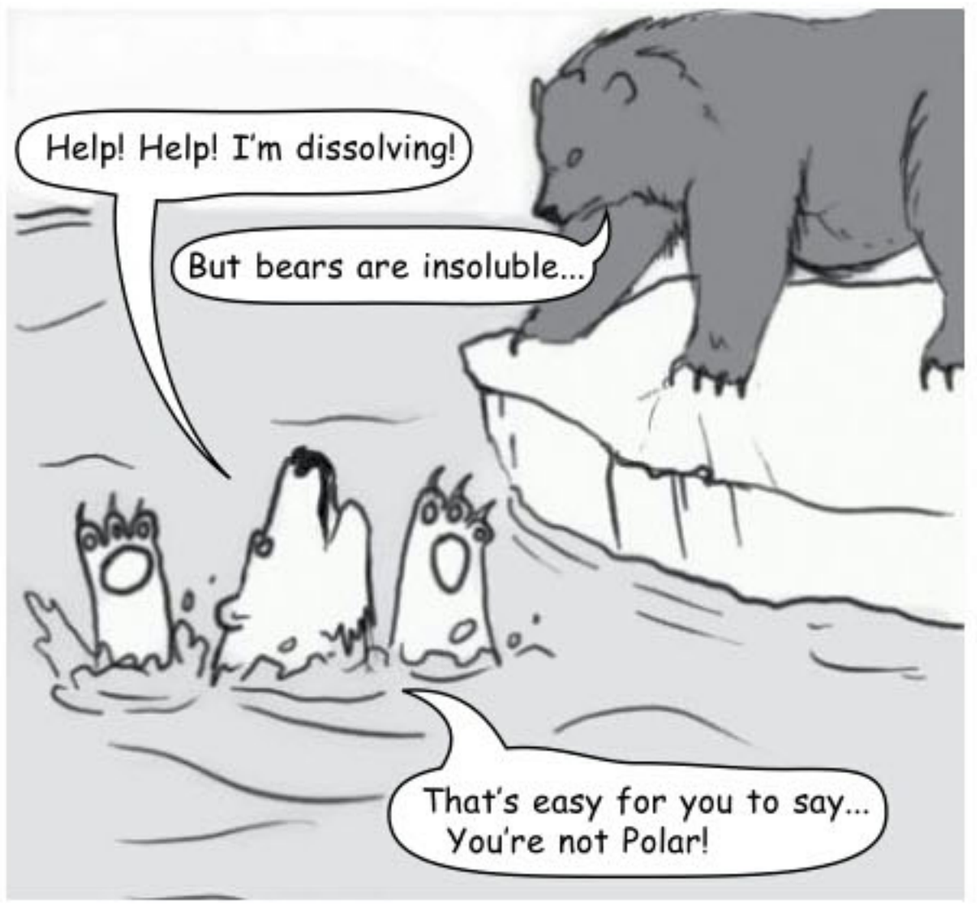
$\Rightarrow q = a \cdot r^{n-1} = a\left(\frac{b}{a}\right)^{\frac{n-1}{2n-2}} = a\left(\frac{b}{a}\right)^{1/2} = \sqrt{ab}$

$\Rightarrow \frac{1}{s} = \frac{1}{a} + (n-1)\left(\frac{\frac{1}{b}-\frac{1}{a}}{2n-2}\right) = \frac{\frac{1}{a}+\frac{1}{b}}{2}$

$\Rightarrow p, q, s$ are the A.M, G.M, H.M of a and b.

$\therefore p \ge q \ge s$ and $ps = q^2$

COMIC CAPSULE



CONCEPT MAP
CLASS XI

HYDROCARBONS

Get well-prepared for exams with quick revision of important concepts of organic chemistry.

Alkanes (C_nH_{2n+2})

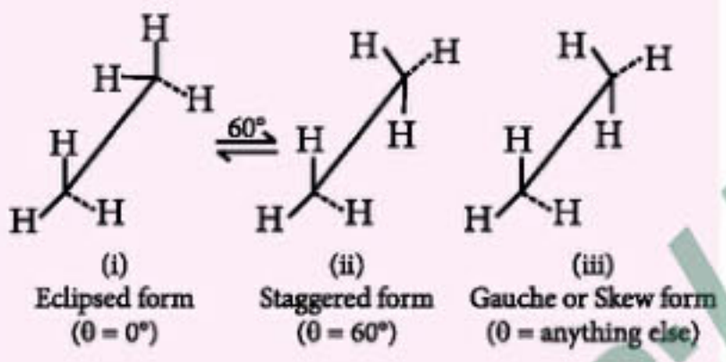
- **Boiling points and melting points :**
- B.pt. and m.pt. $\propto \frac{1}{\text{Branching}}$
- B.pt. $\propto$ molecular mass
- M.pt. $\propto$ symmetrical and close packing
- Alkanes with even no. of carbon atoms are more closely packed and thus show higher m.pt. as compared to next alkane with odd no. of carbon atoms.

Chemical Properties :

- Least reactive because of strong C—C and C—H σ bonds.
- Undergo only substitution reactions.
- Sulphonation and halogenation occur by free radical mechanism.

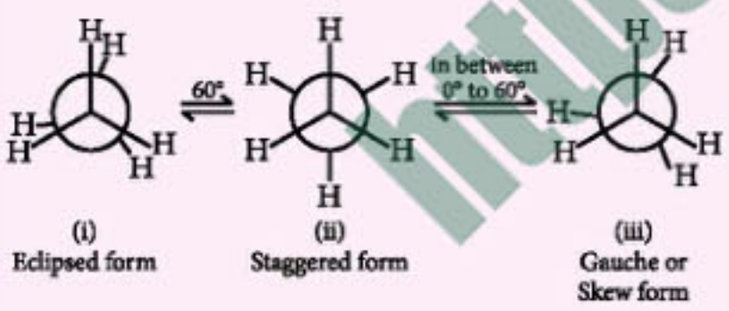
Conformations of Ethane

- **Sawhorse projection :**



(i) Eclipsed form (θ = 0°) | (ii) Staggered form (θ = 60°) | (iii) Gauche or Skew form (θ = anything else)

- **Newmann projection :**



(i) Eclipsed form | (ii) Staggered form | (iii) Gauche or Skew form

Order of Stability

- Staggered (*anti*) > gauche > partially eclipsed > fully eclipsed
- For cyclohexane; chair > half-chair > boat
- **Baeyer's strain theory :**
  Amount of deviation (d) = 1/2(109°28′ – valency angle)

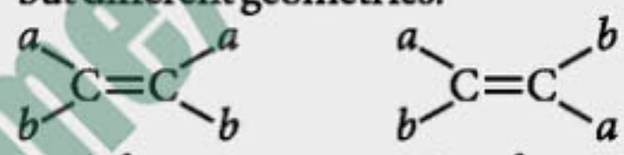
- Addition of symmetrical reagents over symmetrical alkenes can be generalised as :

Alkenes (C_nH_{2n})

- **Boiling points :** *cis*-isomer > *trans*-isomer
- Most substituted alkenes are more stable.
  $R_2C=CR_2 > R_2C=CHR > RCH=CHR$ (*trans*)
  $R_2C=CH_2 > RCH=CHR$ (*cis*) $> RCH=CH_2 > CH_2=CH_2$
- Undergo electrophilic addition reactions.
- **Test for unsaturation :** Gives bromine water and Baeyer's tests.
- Addition of unsymmetrical reagents (HX, H_2O, HOX, etc.) takes place according to Markovnikov's rule.

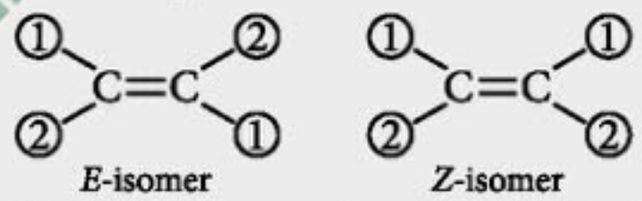
Isomerism

- **Geometrical (*cis-trans*) :** Molecules have identical atomic arrangement but different geometries.



cis-form | *trans*-form

- ***E* and *Z* system :**



E-isomer | *Z*-isomer

- **Calculation of geometrical isomers in polyenes :**
  (a) When the ends of polyene are different, then the number of geometrical isomers = 2^n
  where, n is the number of double bonds.
  (b) When the ends of polyene are same,
  (i) When n is an even number, then the number of geometrical isomers $= 2^{(n-1)} + 2^{(n/2-1)}$
  (ii) When n is an odd number, then the number of geometrical isomers $= 2^{(n-1)} + 2^{\left(\frac{n-1}{2}\right)}$

- *cis*-alkene + *syn*-addition → *meso*-product
- *cis*-alkene + *anti*-addition → *racemic*-product

Alkynes (C_nH_{2n-2})

- **Melting points and boiling points :** Alkynes > Alkenes > Alkanes.
- **Acidity :** Alkynes > Alkenes > Alkanes (as *s*-character $\propto$ acidity).
- **Degree of unsaturation** or index of hydrogen deficiency $= (2n_1 + 2 - n_2)/2$,
  where, n_1 = number of carbon atoms, n_2 = number of hydrogen atoms.
- **Test for unsaturation :** Gives bromine water and Baeyer's test.
- Undergo electrophilic and nucleophilic addition.

Aromatic Compounds

- A compound is said to be aromatic when it is cyclic and planar.
- It has complete delocalisation of π-electrons.
- It follows Huckel's rule, *i.e.*, $(4n + 2)\pi$ electrons. Where, n is a positive integer (0, 1, 2, 3, ...).
- A compound is said to be anti-aromatic when it is cyclic, planar, conjugated and have $4n\pi$ electrons.

Directive influence of Substituents

- ***o*-, *p*-directing groups :** –*R*(alkyl), –OH, –SH, $-NH_2$, $-O^-$, –*OR*, –NH*R*, $-NR_2$, –NHCO*R*, –Cl, –Br, –I, $-CH_2Cl$, $-CH_2OH$, $-CH_2NH_2$, $-CH_2CN$, $-CH_2COOH$, $-CH=CH_2$, $-CH=CHCOOH$, $-C_6H_5$, –N=N, –NC, etc.
- ***m*-directing groups :** $-SO_3H$, $-NO_2$, –CHO, –COOH, –CN, SO_2Cl, –COCl, –COO*R*, –CO*R*, $-CONH_2$, $-CCl_3$, $-CF_3$, $-\overset{+}{N}H_3$, $-\overset{+}{N}H_2R$, $-\overset{+}{N}HR_2$, $-\overset{+}{N}R_3$, etc.

- *trans*-alkene + *syn*-addition → *racemic*-product
- *trans*-alkene + *anti*-addition → *meso*-product

ELECTROCHEMISTRY

Get well-prepared for exams with quick revision of important concepts of physical chemistry.

CONCEPT MAP
CLASS XII

Basic Terms

- **Conductance :**
  $C = \frac{1}{R}$; Unit : Ω^{-1} or S
- **Specific resistance or resistivity :**
  $R = \rho\frac{l}{a} \Rightarrow \rho = R\frac{a}{l}$; Unit : Ω cm or Ω m
  (1 Ω m = 100 Ω cm or 1 Ω cm = 0.01 Ω m)
- **Specific conductance or conductivity :**
  $\kappa = C \times \frac{l}{a}$; Unit : Ω^{-1} cm^{-1} or S cm^{-1}
- **Equivalent conductivity**
  $\Lambda_{eq} = \frac{\kappa \times 1000}{\text{Normality}}$; Unit : S cm^2 eq^{-1}
- **Molar conductivity**
  $\Lambda_m = \frac{\kappa \times 1000}{\text{Molarity}}$; Unit : S cm^2 mol^{-1}

Kohlrausch's law

For a strong electrolyte A_xB_y,
$\Lambda^\circ_m = x\lambda^\circ_+ + y\lambda^\circ_-$
where, Λ°_m = Limiting molar conductivity

Nernst Equation

- $E_{(M^{n+}/M)} = E^\circ_{(M^{n+}/M)} - \frac{0.0591}{n}\log\frac{1}{[M^{n+}]}$ (at 298 K)
  $E_{cell} = E^\circ_{cell} - \frac{0.0591}{n}\log\frac{[\text{Oxidised}]}{[\text{Reduced}]}$ (at 298 K)
- **For concentration cell :**
  $E_{cell} = \frac{0.0591}{n}\log\frac{C_2}{C_1}$; E_{cell} = +ve if $C_2 > C_1$
- **For a reaction in equilibrium :**
  $E^\circ_{cell} = \frac{0.0591}{n}\log K$ at 298 K
  $\Delta_r G^\circ = -nFE^\circ_{cell}$
  $\Delta_r G^\circ = -RT\ln K$

- $\Delta G^\circ_3 = \Delta G^\circ_1 + \Delta G^\circ_2$ (when different number of electrons are involved)
  $-n_3FE^\circ_3 = -n_1FE^\circ_1 - n_2FE^\circ_2$
  $E_{H^+/H_2} = -0.0591\,pH$
- **Relation between free energy and cell potential :**

Type of reaction	ΔG	E	Type of cell
Spontaneous	–ve	+ve	Galvanic
Non-spontaneous	+ve	–ve	Electrolytic
Equilibrium	0	0	Dead battery

Types of Cell

Electrolytic Cell

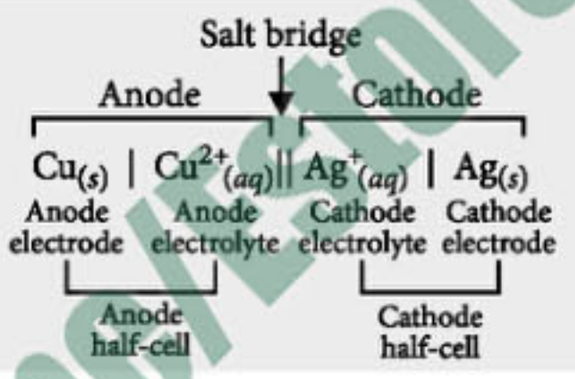
A device which uses electrical energy to carry out some non-spontaneous chemical reactions.

Faraday's first law
$W = Zit$

Faraday's second law
$\frac{W_1}{W_2} = \frac{E_1}{E_2} = \frac{Z_1}{Z_2}$

Electrochemical Cell

A device which converts chemical energy into electrical energy.



$E^\circ_{cell} = E^\circ_{cathode} - E^\circ_{anode}$
or, $E^\circ_{cell} = E^\circ_{right} - E^\circ_{left}$

Fuel Cells

- **H_2-O_2 Fuel Cell**
  Anode : $2H_{2(g)} + 4OH^-_{(aq)} \rightarrow 4H_2O_{(l)} + 4e^-$
  Cathode : $O_{2(g)} + 2H_2O_{(l)} + 4e^- \rightarrow 4OH^-_{(aq)}$
  Net reaction : $2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$
  Uses : In automobiles on experimental basis, for producing electricity in Apollo Space program, etc.
- **Thermodynamic efficiency (η) of a fuel cell** $= \frac{\Delta G}{\Delta H} = -\frac{nFE}{\Delta H}$

Corossion

- **Rusting of iron** : Formation of brown complex of $Fe_2O_3 \cdot xH_2O$ in presence of O_2 and H_2O.
- **Tarnishing of metals :** Formation of thin layer of corrosion over metals such as copper, silver, aluminium, etc.

Some Commercial Cells

Primary Cells

- **Dry cell**
  Anode : Zinc container
  Cathode : Carbon (graphite)
  Electrolyte : Moist paste of $NH_4Cl + ZnCl_2$
  Net reaction : $Zn_{(s)} + 2NH^+_{4(aq)} + 2MnO_{2(s)} \rightarrow Zn^{2+}_{(aq)} + 2MnO(OH)_{(s)} + 2NH_{3(g)}$
  Uses : In transistors and clocks, etc.
- **Mercury cell**
  Anode : Zn-Hg amalgam
  Cathode : Mercury (II) oxide
  Electrolyte : Paste of KOH + ZnO
  Net reaction : $Zn(Hg)_{(s)} + HgO_{(s)} \rightarrow ZnO_{(s)} + Hg_{(l)}$
  Uses : In watches, hearing aids, etc.

Secondary Cells

- **Lead storage cell**
  Anode : Pb; **Cathode :** PbO_2
  Electrolyte : 35-38% H_2SO_4 solution
  Net reaction : $Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)} \rightarrow 2PbSO_{4(s)} + 2H_2O_{(l)}$
  The reverse reaction takes place during recharging :
  $2PbSO_{4(s)} + 2H_2O_{(l)} \rightarrow Pb_{(s)} + PbO_{2(s)} + 2H_2SO_{4(aq)}$
  Uses : In automobiles and inverters.
- **Nickel-cadmium cell**
  Anode : Cadmium
  Cathode : Nickel (IV) oxide
  Electrolyte : KOH solution
  Net reaction : $Cd_{(s)} + 2Ni(OH)_{3(s)} \rightarrow CdO_{(s)} + 2Ni(OH)_{2(s)} + H_2O_{(l)}$
  The reverse reaction takes place during recharging :
  $CdO_{(s)} + 2Ni(OH)_{2(s)} + H_2O_{(l)} \rightarrow Cd_{(s)} + 2Ni(OH)_{3(s)}$
  Uses : In portable electronic devices, emergency lighting, photography equipments, etc.

PRACTICE PAPER

NEET

Exam on
6th May 2018

1. The vapour pressure of a pure liquid *A* is 40 mm Hg at 310 K. The vapour pressure of this liquid in a solution with liquid *B* is 35 mm Hg. Mole fraction of *A* in the solution is 0.8 then
   (i) it is a non-ideal solution having negative deviation.
   (ii) temperature of system is decreased.
   (iii) $\Delta V_{mix} > 0$
   Find the correct statement(s).
   (a) Only (i) (b) Only (ii)
   (c) Only (i) and (ii) (d) Only (ii) and (iii)

2. Which of the following statements is false?
   (a) Artificial silk is derived from cellulose.
   (b) Nylon-6, 6 is an example of elastomer.
   (c) The repeating unit in natural rubber is isoprene.
   (d) Both starch and cellulose are polymers of glucose.

3. An organic compound whose empirical and molecular formulae are same, contains 20% carbon, 6.7% hydrogen, 46.7% nitrogen and the rest oxygen. On heating it yields ammonia, leaving a solid residue. The solid residue gives a violet colour with dilute solution of alkaline copper sulphate. The organic compound is
   (a) NH_2COONH_4 (b) CH_3COONH_4
   (c) NH_2NHCHO (d) NH_2CONH_2

4. Formation of methyl *t*-butylether by the reaction of sodium *t*-butoxide and methylbromide involves
   (a) elimination reaction
   (b) electrophilic addition reaction
   (c) nucleophilic addition reaction
   (d) nucleophilic substitution reaction.

5. Unlike the other elements of its group, carbon does not form CX_2 type molecules because
   (a) energetically this is not possible
   (b) carbon undergoes catenation
   (c) it is non-metallic
   (d) carbon does not contain *d*-orbital.

6. Which of the following is not a surfactant?
   (a) $CH_3-(CH_2)_{15}-\overset{\overset{CH_3}{|}}{\underset{\underset{CH_3}{|}}{N^+}}-CH_3\,Br^-$
   (b) $CH_3-(CH_2)_{14}-CH_2NH_2$
   (c) $CH_3-(CH_2)_{16}-CH_2OSO_2^-Na^+$
   (d) $OHC-(CH_2)_{14}-CH_2COO^-Na^+$

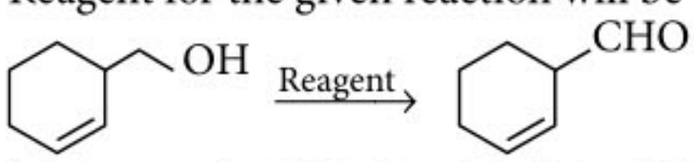
7. Which of the following is not correctly matched?
   (a) $[Ni(CN)_4]^{2-}$: square planar, diamagnetic
   (b) $[Ni(PPh_3)_4]^{2+}$: square planar, diamagnetic
   (c) $[Ni(CO)_4]$: tetrahedral, paramagnetic
   (d) $[NiCl_4]^{2-}$: tetrahedral, paramagnetic

8. For the reaction : $2A + B \rightarrow C + D$, measurement of the rate of the reaction at varying concentrations are given below :

Expt.No.	[*A*]	[*B*]	Rate (mmol L^{-1} s^{-1})
1.	0.010	0.010	2.5
2.	0.010	0.020	5.0
3.	0.030	0.020	45.0

   The rate law is, therefore
   (a) rate = $k[A]^2[B]$ (b) rate = $k[A][B]^2$
   (c) rate = $k[A][B]$ (d) rate = $k[A]^2[B]^2$

9. Reagent for the given reaction will be



   (a) hot acidic $KMnO_4$ (b) CrO_3, H^+
   (c) CrO_3, pyridine, CH_2Cl_2
   (d) dil. alkaline $KMnO_4$.

10. Aspartame is one of the good artificial sweeteners whose use is limited to cold foods and soft drinks because
(a) aspartame has very low boiling point
(b) aspartame gets dissociated at cooking temperature
(c) aspartame is a sweetener at low temperatures only
(d) aspartame is not soluble at higher temperatures.

11. Four diatomic species are listed below in different sequences. Which of these represents the correct order of their increasing bond order?
(a) $C_2^{2-} < He_2^+ < NO < O_2^-$
(b) $He_2^+ < O_2^- < NO < C_2^{2-}$
(c) $O_2^- < NO < C_2^{2-} < He_2^+$
(d) $NO < C_2^{2-} < O_2^- < He_2^+$

12. In which of the following reactions, the given product is incorrect?
(a) $Ph-MgBr \xrightarrow{O_2} \xrightarrow{H^+} Ph-OH$
(b) $CH_3-CH_2-MgBr \xrightarrow{CO_2} \xrightarrow{H^+} CH_3-CH_2-COOH$
(c) $CH_3-CH=O \xrightarrow{PhMgBr} \xrightarrow{H^+} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-Ph$
(d) $CH_3C\equiv N \xrightarrow{PhMgBr} \xrightarrow{H^+} CH_3-\underset{\displaystyle OH}{\underset{|}{CH}}-Ph$

13. A gas expands from 3 dm^3 to 5 dm^3 against a constant pressure of 3 atm. The work done during expansion is used to heat 10 moles of water at 290 K. Calculate final temperature of water.
(Specific heat of water = 4.184 $J\,g^{-1}K^{-1}$)
(a) 290 K (b) 290.81 K
(c) 289.19 K (d) 289.52 K

14. An organic compound, C_3H_9N (*A*), when treated with nitrous acid, gave an alcohol (*B*) and N_2 gas was evolved. (*A*) on warming with $CHCl_3$ and caustic potash gave (*C*) which on reduction gave isopropylmethyl amine. Predict the structure of (*A*).
(a) $\begin{matrix}CH_3\\ \diagdown\\ \quad CH-NH_2\\ \diagup\\ CH_3\end{matrix}$ (b) $CH_3CH_2-NH-CH_3$
(c) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{N}}-CH_3$ (d) $CH_3CH_2CH_2-NH_2$

15. $AlCl_3$ is an electron deficient compound but AlF_3 is not. This is because
(a) atomic size of F is smaller than Cl which makes AlF_3 more covalent
(b) $AlCl_3$ is a covalent compound while AlF_3 is an ionic compound
(c) $AlCl_3$ exists as a dimer but AlF_3 does not
(d) Al in $AlCl_3$ is in sp^3 hybrid state but Al in AlF_3 is in sp^2 hybrid state.

16. The amino acid, $H_2NCH(\underset{\displaystyle COOH}{\underset{|}{\ }})(CH_2)_2COOH$ at high pH exists as
(a) $H_3\overset{+}{N}CH(\underset{\displaystyle COOH}{\underset{|}{\ }})(CH_2)_2COOH$
(b) $H_3\overset{+}{N}CH(\underset{\displaystyle COO^-}{\underset{|}{\ }})(CH_2)_2COOH$
(c) $H_3\overset{+}{N}CH(\underset{\displaystyle COO^-}{\underset{|}{\ }})(CH_2)_2COO^-$
(d) $H_2NCH(\underset{\displaystyle COO^-}{\underset{|}{\ }})(CH_2)_2COO^-$

17. The incorrect statement is
(a) in metallurgy of iron, flux is a substance used to convert infusible impurities to fusible mass
(b) cryolite is Na_3AlF_6 and is used in the electrolysis of alumina for lowering the melting point of alumina
(c) combination of FeO with SiO_2 must be avoided in metallurgy of copper
(d) lead can be extracted by self reduction of galena.

18. Alkali metals are generally extracted by
(a) reduction methods
(b) double decomposition methods
(c) displacement methods
(d) electrolytic methods.

19. In S_N2 substitution reaction of the type,
$R-Br + Cl^- \xrightarrow{DMF} R-Cl + Br^-$
which one of the following has the highest relative rate?
(a) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{\overset{\displaystyle CH_3}{\overset{|}{C}}}}-CH_2Br$ (b) CH_3CH_2Br
(c) $CH_3CH_2CH_2Br$ (d) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_2Br$

20. The electrons identified by quantum numbers n and l:
(1) $n = 4, l = 1$ (2) $n = 4, l = 0$
(3) $n = 3, l = 2$ (4) $n = 3, l = 1$
can be placed in order of increasing energy as
(a) (4) < (2) < (3) < (1) (b) (2) < (4) < (1) < (3)
(c) (1) < (3) < (2) < (4) (d) (3) < (4) < (2) < (1)

21. Which of the following isomeric heptanes can yield seven different monochlorinated products upon free radical chlorination?
(a) 3-Methylhexane (b) 2,2-Dimethylpentane
(c) 2-Methylhexane (d) 2,3-Dimethylpentane

22. Which reagent is not suitable for the following conversion?
$Ph-CH=O \xrightarrow{Reagent} Ph-COOH$
(a) Tollens' reagent (b) Fehling solution
(c) $K_2Cr_2O_7, H^+$ (d) Acidic $KMnO_4$

23. Of two oxides of iron, the first contains 22% and the second contains 30% of oxygen by weight. The ratio of weights of iron in the two oxides that combine with the same weight of oxygen is
(a) 3 : 2 (b) 2 : 1 (c) 1 : 2 (d) 1 : 1

24. The decreasing order of reactivity of the following towards OH^- ions is
(I) *m*-Nitrobromobenzene
(II) 2,4,6-Trinitrobromobenzene
(III) *p*-Nitrobromobenzene
(IV) 2,4-Dinitrobromobenzene
(a) I > II > III > IV (b) II > IV > III > I
(c) IV > II > III > I (d) II > IV > I > III

25. The difference between heat of formation at constant pressure and constant volume for the reaction,
$2C_6H_{6(l)} + 15O_{2(g)} \longrightarrow 12CO_{2(g)} + 6H_2O_{(l)}$
at 25 °C (in kJ) is
(a) –7.43 (b) +3.72 (c) –3.72 (d) +7.43

26. In the Arrhenius equation for a certain reaction, the values of A and E_a (activation energy) are 4×10^{13} s^{-1} and 98.6 kJ mol^{-1} respectively. If the reaction is of first order, at what temperature will its half-life period be ten minutes?
(log 0.001155 = –2.9374 and log 4 = 0.6020)
(a) 323.56 K (b) 311.35 K
(c) 275.01 K (d) 510.05 K

27. pH of a saturated solution of magnesium hydroxide in water at 298 K is 10. The solubility of the hydroxide in water at 298 K is
(a) 5×10^{-5} mol L^{-1} (b) 5×10^{-12} mol L^{-1}
(c) 1×10^{-4} mol L^{-1} (d) 1×10^{-10} mol L^{-1}

28. IUPAC name of $BrCH_2(CONH_2)CHCOCH_2CH_3$ is
(a) 3-(bromoethyl)-3-oxopentanamide
(b) 2-(bromoethyl)-3-ketopentanamide
(c) 2-(bromoethyl)-3-oxopentanamide
(d) 2-(bromomethyl)-3-oxopentanamide.

29. Zinc and mercury do not show variable valency like other *d*-block elements because
(a) they are soft
(b) their *d*-orbitals are complete
(c) they have only two electrons in the outermost shell
(d) their *d*-orbitals are incomplete.

30. A correct electrochemical series (increasing SRP) can be obtained from Li, K, Zn, Fe, H, Ag, Cu, Au by interchanging
(a) K and Li (b) Zn and Fe
(c) Ag and Cu (d) Fe and H.

31. X mL of H_2 gas effuses through a hole in a container in 5 seconds. The time taken for the effusion of the same volume of the gas specified below under identical conditions is
(a) 10 seconds : He (b) 20 seconds : O_2
(c) 25 seconds : CO (d) 35 seconds : CO_2

32. Which of the following statements is incorrect?
(a) In $K_3[Fe(CN)_6]$, the ligand has satisfied only the secondary valency of ferric ion.
(b) In $K_3[Fe(CN)_6]$, the ligand has satisfied both primary and secondary valencies of ferric ion.
(c) In $K_4[Fe(CN)_6]$, the ligand has satisfied both primary and secondary valencies of ferrous ion.
(d) In $[Cu(NH_3)_4]SO_4$, the ligand has satisfied only the secondary valency of copper.

33. Solid $Ba(NO_3)_2$ is gradually dissolved in a 1.0×10^{-4} M Na_2CO_3 solution. At what concentration of Ba^{2+} will a precipitate begin to form?
(K_{sp} for $BaCO_3 = 5.1 \times 10^{-9}$)
(a) 4.1×10^{-5} M (b) 5.1×10^{-5} M
(c) 8.1×10^{-8} M (d) 8.1×10^{-7} M

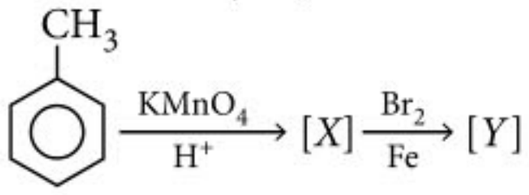
34. When a metal is to be extracted from its ore and if the gangue associated with the ore is silica, then
(a) an acidic flux is needed
(b) a basic flux is needed
(c) both acidic and basic flux are needed
(d) neither of them is needed.

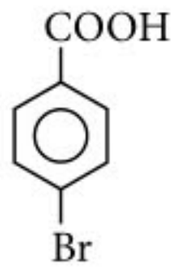
35. The secondary precursors of photochemical smog are
(a) SO_2 and NO_2 (b) SO_2 and hydrocarbons
(c) NO_2 and PAN (d) O_3 and PAN.

36. When $KMnO_4$ acts as an oxidising agent and ultimately forms MnO_4^{2-}, MnO_2, Mn_2O_3 and Mn^{2+}, then the number of electrons transferred in each case respectively is
(a) 4, 3, 1, 5 (b) 1, 5, 3, 7
(c) 1, 3, 4, 5 (d) 3, 5, 7, 1

37. For *AX* ionic crystal to exist in *bcc* structure, the radius ratio $\left(\frac{r_{cation}}{r_{anion}}\right)$ should be
(a) between 0.41 and 0.73
(b) greater than 0.73
(c) less than 0.41
(d) equal to 1.0

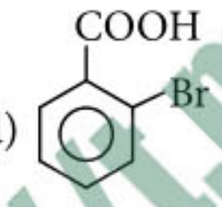
38. The final major product of the given reaction is



(a) 

(b) 

(c) 

(d) 

39. Concentrated sulphuric acid can be reduced by
(a) NaCl (b) NaOH (c) $NaNO_3$ (d) NaBr

40. Increasing order of ionic size for the ions, F^-, O^{2-}, Na^+, Al^{3+} is
(a) $O^{2-} < F^- < Na^+ < Al^{3+}$
(b) $Al^{3+} < Na^+ < F^- < O^{2-}$
(c) $O^{2-} < Na^+ < F^- < Al^{3+}$
(d) $Al^{3+} < F^- < Na^+ < O^{2-}$

41. Which of the following statements is incorrect regarding physisorption?
(a) It occurs because of van der Waals' forces.
(b) More easily liquefiable gases are adsorbed readily.
(c) Under high pressure, it results into multimolecular layer on adsorbent surface.
(d) Enthalpy of adsorption ($\Delta H_{adsorption}$) is low and positive.

42. Which of the following choices is correct?
(a) Basicity order : $I^- > Br^- > Cl^- > F^-$.
(b) Nucleophilicity order : $CH_3—O^- < Ph—O^- < CH_3—COO^- < CH_3—SO_3^-$.
(c) Nucleophilicity order in polar protic solvent : $I^- > Cl^- > Br^- > F^-$.
(d) Leaving group ability order : $I^- > Br^- > Cl^- > F^-$.

43. Which of the following is not the characteristic of interhalogen compounds?
(a) They are more reactive than halogens.
(b) They are quite unstable but none of them is explosive.
(c) They are covalent in nature.
(d) They have low boiling points and are highly volatile.

44. In a cubic lattice each edge length of the unit cell is 400 pm. Atomic weight of the element is 60 and the density of the unit cell is 6.25 g/cc ($N_A = 6 \times 10^{23}$). The crystal lattice is
(a) face-centred (b) primitive
(c) body-centred (d) end-centred.

45. Heavy water is manufactured
(a) by repeated electrolysis of 3% aqueous NaOH
(b) by electrolysis of water containing heavy hydrogen dissolved in it
(c) by combination of hydrogen and heavier isotope of oxygen
(d) none of the above.

SOLUTIONS

1. (d) : $P_A = 40 \times 0.8 = 32$ mm (*i.e.*, < 35 mm)
$\therefore$ The solution shows positive deviation.

2. (b) : Nylon 6, 6 is an example of fibres.

3. (d) :

Element	%	Atomic mass	Relative no. of atoms	Simplest ratio
C	20%	12	1.66	1
H	6.7%	1	6.7	4
N	46.7%	14	3.33	2
O	26.6%	16	1.66	1

Empirical formula = Molecular formula = CH_4N_2O or NH_2CONH_2

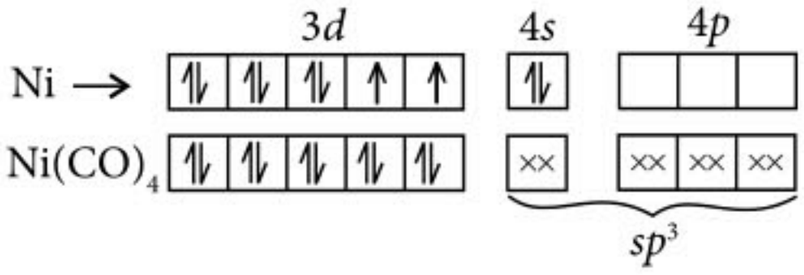
$NH_2CONH_2 \xrightarrow{\Delta} NH_3 + HCNO$

4. (d) : The formation of methyl *t*-butylether by the reaction of sodium *t*-butoxide and methylbromide involves nucleophilic substitution (S_N2) reaction in which bromine is replaced by *t*-butoxy group.

5. (a)

6. (b)

7. (c) : $Ni(CO)_4$ is a tetrahedral complex and is diamagnetic due to absence of unpaired electrons.



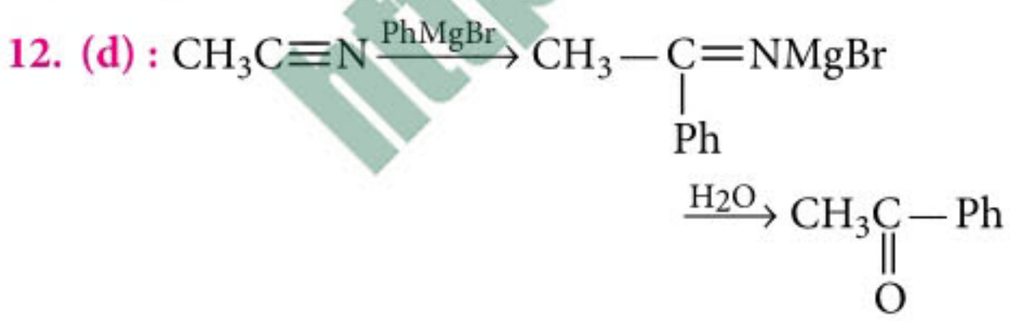
8. (a) : From experiments 1 and 2, $[A]$ is kept constant, $[B]$ is doubled, rate is doubled. Thus, rate $\propto [B]$.
From experiments 2 and 3, $[B]$ is kept constant, $[A]$ is tripled, rate becomes 9 times so, rate $\propto [A]^2$.
Overall rate $\propto [A]^2[B]$ or rate $= k[A]^2[B]$

9. (c) : Mild oxidising agents like PCC can oxidise only alcohols into carbonyl compounds.

10. (b) : Aspartame gets dissociated at cooking temperature.

11. (b) : According to molecular orbital theory, the energy level of the given molecules are
$C_2^{2-}(14) : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \pi 2p_x^2 = \pi 2p_y^2, \sigma 2p_z^2$
B.O. $= 1/2[10 - 4] = 3$
$He_2^+(3) : \sigma 1s^2, \sigma^* 1s^1$
B.O. $= 1/2[2 - 1] = 1/2 = 0.5$
NO $(15) : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2,$
$\pi 2p_x^2 = \pi 2p_y^2, \pi^* 2p_x^1$
B.O. $= 1/2[10 - 5] = 2.5$
$O_2^-(17) : \sigma 1s^2, \sigma^* 1s^2, \sigma 2s^2, \sigma^* 2s^2, \sigma 2p_z^2, \pi 2p_x^2 = \pi 2p_y^2,$
$\pi^* 2p_x^2 = \pi^* 2p_y^1$
B.O. $= 1/2[10 - 7] = 1.5$
So, the correct order of their increasing bond order is
$He_2^+ < O_2^- < NO < C_2^{2-}$.

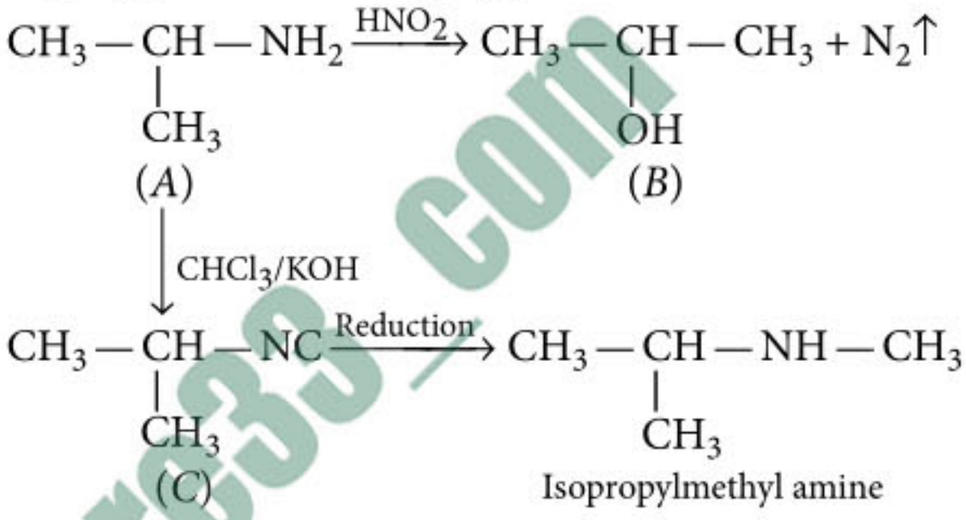
12. (d) :



13. (b) : Work done is against constant external pressure, hence, process is irreversible.
$w = -P\Delta V$, $\Delta V = V_2 - V_1 = 5 - 3 = 2\ dm^3$,
$\Delta V = 2 \times 10^{-3}\ m^3$
$P = 3\ atm = 3 \times 1.013 \times 10^5\ N\ m^{-2}$
$\therefore \quad w = -3 \times 1.013 \times 10^5 \times 2 \times 10^{-3} = -607.8\ J$
Expansion work done $= -607.8\ J$

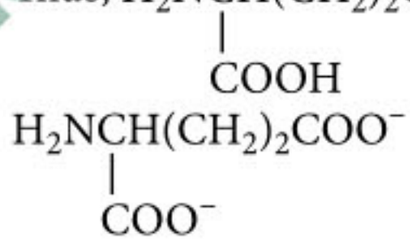
Work is used to heat water therefore,
$-w = q = m \times C \times \Delta T$,
$607.8 = 10 \times 18 \times 4.184 \times 18 \times \Delta T$ or $\Delta T = 0.81\ K$
$\therefore$ Final temperature of water $= 290 + 0.81 = 290.81\ K$

14. (a) : As '*A*' gives an alcohol on treatment with nitrous acid thus, it should be primary amine. C_3H_9N has two possible structures with $-NH_2$ group.
$CH_3-CH_2-CH_2-NH_2$ or $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-NH_2$
As it gives isopropylmethyl amine thus, it should be isopropyl amine not *n*-propyl amine.



15. (b)

16. (d) : In highly alkaline conditions or at high pH, the carboxylic group is deprotonated.
Thus, $H_2NCH(CH_2)_2COOH$ exists as



17. (c)

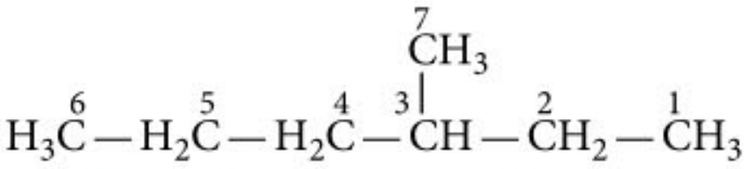
18. (d) : Alkali metals are highly electropositive and thus, highly reducing agents. Therefore, reduction, double decomposition and displacement methods for their extraction are not suitable. Only electrolytic methods are useful for their extraction.

19. (b) : S_N2 mechanism is followed in case of primary and secondary alkyl halides *i.e.*, S_N2 reaction is favoured by small groups on the carbon atoms attached to halogen so, $CH_3-X > R-CH_2-X > R_2CH-X > R_3C-X$.
Primary alkyl halides are is more reactive than secondary and tertiary alkyl halides.

20. (a) : For (1) $n + l = 5$; $n = 4$
(2) $n + l = 4$; $n = 4$
(3) $n + l = 5$; $n = 3$
(4) $n + l = 4$; $n = 3$

Lower $(n + l)$ means less energy and if for two subshells $(n + l)$ is same then lower the value of n, lower will be the energy.
Thus, correct order is (4) < (2) < (3) < (1).

21. (a) : 3-Methylhexane can yield seven different mono-chlorinated products upon free radical chlorination, as the chemical environment of all the seven carbon atoms is different.



22. (b) : Fehling solution does not oxidise aromatic aldehydes.

23. (a) : % of oxygen in first oxide = 22
% of metal in first oxide = (100 – 22) = 78
Now, % of oxygen in second oxide = 30
so, % of metal in second oxide = 70
In first oxide, 22 g of oxygen combines with 78 g of metal.
x g of oxygen combines with $\frac{78}{22} \times x$ g of metal (Fe)
In second oxide,
30 g of oxygen combines with 70 g of metal (Fe)
x g of oxygen combines with $\frac{70}{30} \times x$ g of metal (Fe)
$\therefore$ Ratio of weights of metal (Fe) in the two oxides which combines with the same weight of oxygen

$$= \frac{\frac{78}{22} \times x}{\frac{70}{30} \times x} = \frac{3}{2} = 3:2$$

24. (b) : Reactivity decreases as the number of $-NO_2$ groups at *o*- and *p*-positions with respect to Br decreases. *m*-Nitrobromobenzene is, however, less reactive than the *p*-nitrobromobenzene since, the $-NO_2$ group at *m*-position cannot stabilise the intermediate carbanion by resonance. Thus, the order is II > IV > III > I.

25. (a) : We know that $\Delta H = \Delta E + \Delta n_g RT$
$\therefore \quad \Delta H - \Delta E = \Delta n_g RT$
Then for the reaction,
$2C_6H_{6(l)} + 15O_{2(g)} \longrightarrow 12CO_{2(g)} + 6H_2O_{(l)}$
$\therefore \quad \Delta n_g$ = no. of moles of gaseous product – no. of moles of gaseous reactant
$= 12 - 15 = -3$
$\therefore \quad \Delta H - \Delta E = \Delta n_g RT = -3 \times 8.314 \times (273 + 25)$
$= -7432.71 \text{ J} \approx -7.43 \text{ kJ}$

26. (b) : For a first order reaction, $t_{1/2} = 0.693/k$
or $k = 0.693/t_{1/2}$

$$\therefore k = \frac{0.693}{10 \text{ min}} = 0.0693 \text{ min}^{-1} \simeq \frac{0.0693}{60} \text{ s}^{-1} = 0.001155 \text{ s}^{-1}$$

Now, from the Arrhenius equation, $k = Ae^{-E_a/RT}$

or $\ln k = \ln A - \frac{E_a}{RT}$ or $\log k = \log A - \frac{E_a}{2.303RT}$

Substituting the given values, we get

$$\log 0.001155 = \log(4 \times 10^{13}) - \frac{98.6 \times 10^3}{2.303 \times 8.314 \times T}$$

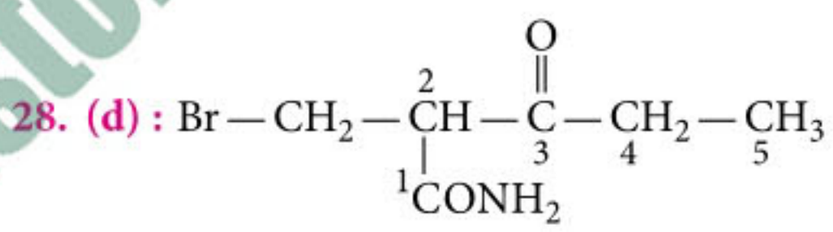
or $-2.9374 = 13.6020 - \frac{5149.6}{T}$

Hence, $T = \frac{5149.6}{(13.6020 + 2.9374)} \text{ K} = 311.35 \text{ K}$

27. (a) : $Mg(OH)_2 \rightleftharpoons \underset{s}{Mg^{2+}} + \underset{2s}{2OH^-}$

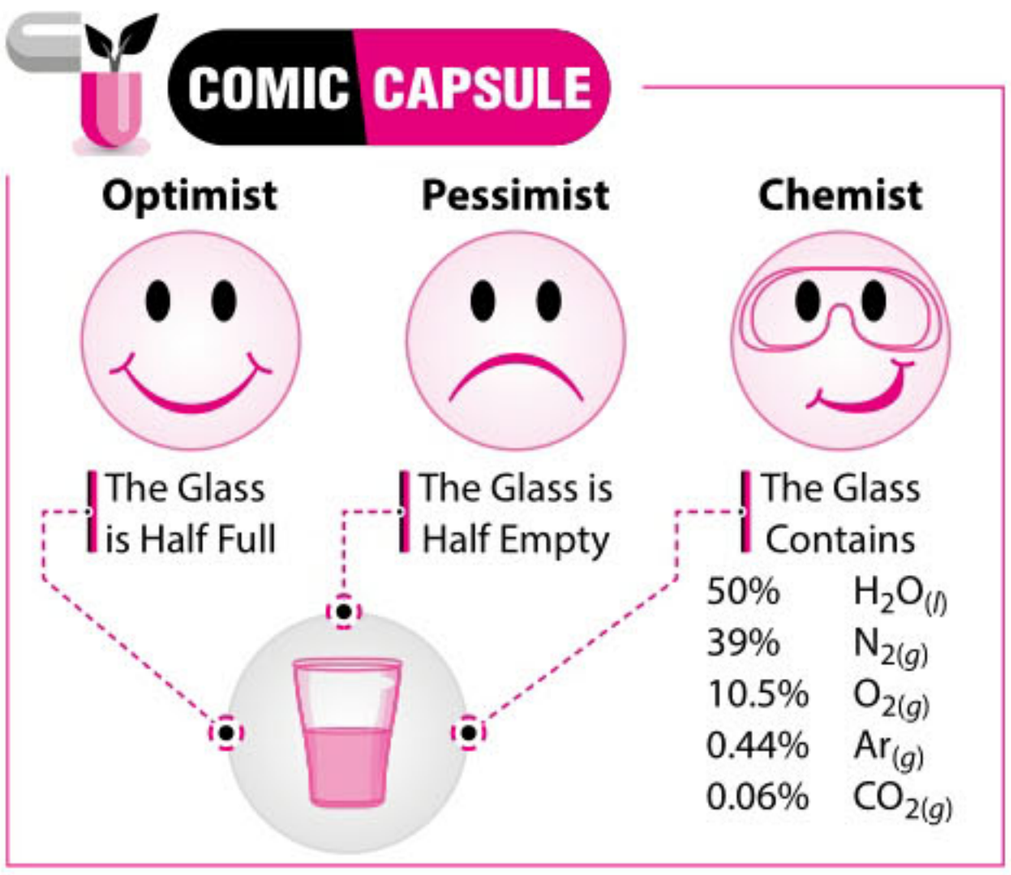
pH of $Mg(OH)_2$ solution is 10.
$\therefore \quad$ pOH = 4
So, $[OH^-] = 10^{-4}$
$[OH^-] = 2 \times$ solubility
$\therefore \quad$ Solubility $= \frac{10^{-4}}{2} = 0.5 \times 10^{-4} = 5 \times 10^{-5} \text{ mol L}^{-1}$

28. (d) :



2-Bromomethyl-3-oxopentanamide.
Terminal functional group, $-CONH_2$ is given more preference over $-\overset{\overset{O}{\|}}{C}-$.

29. (b) **30. (c)**



31. (b) : $\frac{r_{H_2}}{r_{He}} = \sqrt{\frac{4}{2}} = \sqrt{2}$

$\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{32}{2}} = 4$

$\frac{r_{H_2}}{r_{CO}} = \sqrt{\frac{28}{2}} = \sqrt{14}$

$\frac{r_{H_2}}{r_{CO_2}} = \sqrt{\frac{44}{2}} = \sqrt{22}$

Since, $\frac{r_{H_2}}{r_{O_2}} = 4$

i.e., O_2 will take 4 times more time to diffuse

$= 4 \times 5$ seconds $= 20$ seconds.

32. (a) : In $K_3[Fe(CN)_6]$, the ligand has satisfied both primary and secondary valencies of ferric ion.

33. (b) : $K_{sp}(BaCO_3) = [Ba^{2+}][CO_3^{2-}] = 5.1 \times 10^{-9}$

Given, $[CO_3^{2-}] = 1 \times 10^{-4}$ M (from Na_2CO_3)

$\therefore\ 5.1 \times 10^{-9} = [Ba^{2+}] \times (10^{-4}) \Rightarrow [Ba^{2+}] = 5.1 \times 10^{-5}$ M

Thus, when $[Ba^{2+}] = 5.1 \times 10^{-5}$ M, $BaCO_3$ precipitate will begin to form.

34. (b) : Silica is acidic impurity. To remove acidic impurities, basic flux is required like $CaCO_3$.

$CaCO_3 + SiO_2 \rightarrow CaSiO_3 + CO_2\uparrow$

Basic flux — Acidic gangue — Slag (fusible)

35. (d)

36. (c) : $\overset{+7}{KMnO_4} \xrightarrow{+1e^-} \overset{+6}{MnO_4^{2-}}$

$\overset{+7}{KMnO_4} \xrightarrow{+3e^-} \overset{+4}{MnO_2}$

$\overset{+7}{KMnO_4} \xrightarrow{+4e^-} \frac{1}{2}\overset{+3}{Mn_2O_3}$

$\overset{+7}{KMnO_4} \xrightarrow{+5e^-} Mn^{2+}$

37. (b) : For ionic crystal *AX* to exist in *bcc* structure, radius ratio should lie between 0.732 – 1.

38. (b) : 

39. (d) : NaBr reduces conc. H_2SO_4 and Br_2 is liberated.

$2NaBr + 2H_2SO_4 \rightarrow Na_2SO_4 + SO_2 + Br_2 + 2H_2O$

40. (b) : Size of ions depend on $\frac{Z}{e}$ ratio, larger is the $\frac{Z}{e}$ ratio, smaller will be the ion.

(i) $F^- = \frac{Z}{e} = \frac{9}{10} = 0.9$

(ii) $O^{2-} = \frac{Z}{e} = \frac{8}{10} = 0.8$

(iii) $Na^+ = \frac{Z}{e} = \frac{11}{10} = 1.1$

(iv) $Al^{3+} = \frac{Z}{e} = \frac{13}{10} = 1.3$

Thus, $Al^{3+} < Na^+ < F^- < O^{2-}$

41. (d) : Physical adsorption is an exothermic process (*i.e.*, ΔH = –ve) but its value is quite low because the attraction between the gas molecules and solid surface is weak van der Waals' forces.

42. (d) : CH_3O^- is stronger nucleophile than that of CH_3COO^-.

$F^- \quad Cl^- \quad Br^- \quad I^-$ ⟶

basicity decreases
nucleophilicity increases
leaving group ability increases

43. (d) : Interhalogen compounds are mostly liquid or solid at room temperature. They are not volatile.

44. (a) : Let the number of atoms in a unit cell be *x*.

Mass of *x* atoms *i.e.*, one unit cell $= \frac{60 \times x}{6 \times 10^{23}}$

Volume of the unit cell= (edge length)^3

$= (400 \times 10^{-12} \times 100)^3$

$= (400 \times 10^{-10}\ cm)^3$

$= (4 \times 10^{-8}\ cm)^3 = 64 \times 10^{-24}\ cm^3$

$\text{Density} = 6.25 = \frac{\text{Mass of unit cell}}{\text{Volume of unit cell}}$

$\therefore\quad 6.25 = \frac{60 \times x}{6 \times 10^{23} \times 64 \times 10^{-24}}$

$x = \frac{6.25 \times 6 \times 64 \times 10^{-1}}{60} = 4$

Since, the unit cell contains 4 atoms, so it is face-centred cubic unit cell.

45. (a) : Heavy water is manufactured by repeated electrolysis of water (containing a little NaOH).

ADVANCED CHEMISTRY BLOC

(HYDROLYSIS)

Mukul C. Ray, Odisha

HYDROLYSIS AND HYDRATION

In continuation to our last discussion about hydrolysis and hydration reactions, we have a bunch of many important reactions.

Carbides may be ionic or covalent or even interstitial. Ionic carbides are further classified as methanide (C^{4-}), acetylide ($\bar{C}\equiv\bar{C}$) or allylide (C_3^{4-}). These are very strong conjugate bases of their respective hydrocarbons. On treatment with water, these ionic carbides pick H^+ and become respective hydrocarbon.

Examples of methanide hydrolysis are :

$$Al_4C_3 + H_2O \longrightarrow Al(OH)_3 + CH_4$$

$$Be_2C + H_2O \longrightarrow Be(OH)_2 + CH_4$$

Hydrolysis of few acetylides are :

$$CaC_2 + H_2O \longrightarrow Ca(OH)_2 + C_2H_2$$

$$MgC_2 + H_2O \longrightarrow Mg(OH)_2 + C_2H_2$$

Besides group 2 elements, lanthanides and Li from alkali metals form acetylide.

C_3^{4-}, the allylide ion may be

$$\bar{\bar{C}}=C=\bar{\bar{C}} \quad \text{or} \quad \bar{C}\equiv C-C^{3-}$$

Accordingly on hydrolysis, it releases

$$CH_2=C=CH_2 \quad \text{or} \quad CH_3-C\equiv CH$$

The only known allylide is of Mg^{2+} *i.e.*, Mg_2C_3

$$MgC_2 \xrightarrow{\Delta} Mg_2C_3$$

What about covalent carbides?

$$SiC + H_2O \longrightarrow \text{No hydrolysis}$$

SiC has a giant covalent structure. Even conc. HNO_3 fails to disrupt the structure. Only an aq. KOH can dissolve it.

Nitrides on hydrolysis releases NH_3.

$$Mg_3N_2 + H_2O \longrightarrow Mg(OH)_2 + NH_3$$

$$Ca_3N_2 + H_2O \longrightarrow Ca(OH)_2 + NH_3$$

Ionic hydrides like NaH, CaH_2, hydrolyse to release H_2.

$$NaH + H_2O \longrightarrow NaOH + H_2$$

$$CaH_2 + H_2O \longrightarrow Ca(OH)_2 + H_2$$

BeH_2 is a polymeric acid and has characteristic intermediate between that of ionic and covalent. It can withstand water but decomposes in acid to release H_2.

In hydration reactions, compounds will just pick the water.

$$\underset{\text{(A basic anhydride)}}{CaO} + H_2O \longrightarrow Ca(OH)_2$$

Most of the metal oxides are basic anhydrides except a few like Mn_2O_7, CrO_3, etc. With high positive oxidation states, these metals have now developed considerable non-metallic character and their oxides behave as acidic oxides.

Mn_2O_7 reacts with water to form soluble MnO_4^- ions and H^+.

Though we say metal oxides are basic anhydride, practically most of them are insoluble in water. Only oxides of Group-I and few higher members of group-II dissolve in water forming hydroxides. BeO and MgO are also practically insoluble. Their basic nature becomes apparent only when they are reacted with acid. Take another simple example FeO, which is basic but completely insoluble in water, forget about reactions.

Out of non-metal oxides, CO, NO, N_2O are neutral members.

$$\underset{\text{(very little soluble)}}{CO_2} + H_2O \longrightarrow H_2CO_3$$

$$\underset{\text{(It's a mixed anhydride)}}{NO_2} + H_2O \longrightarrow HNO_2 + HNO_3$$

Quotable Quote

Nothing in life is to be feared, it is only to be understood. Now is the time to understand more, so that we may fear less.

Marie Curie

HNO_2 disproportionates to form HNO_3 and NO. Hence, there is nothing wrong when we write

$$NO_2 + H_2O \longrightarrow HNO_3 + NO$$
$$N_2O_5 + H_2O \longrightarrow HNO_3$$
$$N_2O_3 + H_2O \longrightarrow HNO_2$$

Similarly,

$$P_4O_6 + H_2O \text{ (cold)} \longrightarrow H_3PO_3$$
$$P_4O_6 + H_2O \text{ (hot)} \longrightarrow H_3PO_4 + PH_3$$

All the intermediate oxidation states of phosphorus has a tendency to undergo disproportionation to +5 and –3 both in acidic and in alkaline medium.

$$P_4O_{10} + H_2O \longrightarrow H_3PO_4$$

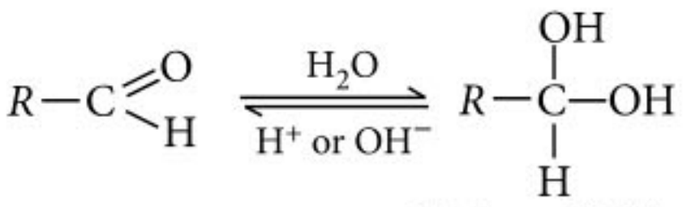
And,

$$Cl_2O_7 + H_2O \longrightarrow HClO_4$$
$$Cl_2O_6 + H_2O \longrightarrow HClO_3 + HClO_4$$
$$ClO_2 + H_2O \longrightarrow HClO_2 + HClO_3$$
$$Cl_2O + H_2O \longrightarrow HClO$$

Cl_2O_6 and ClO_2 are mixed anhydride.

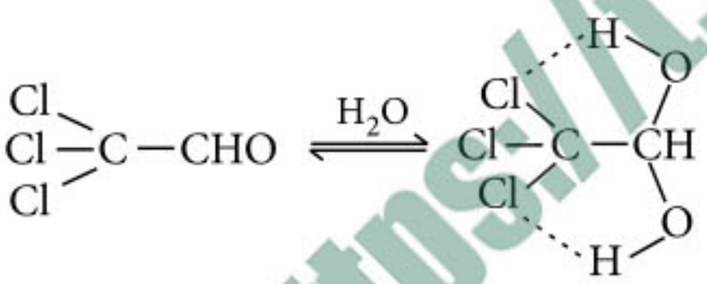
What about hydration in organic compounds?

Note that we have discussed hydrolysis in our previous episode.



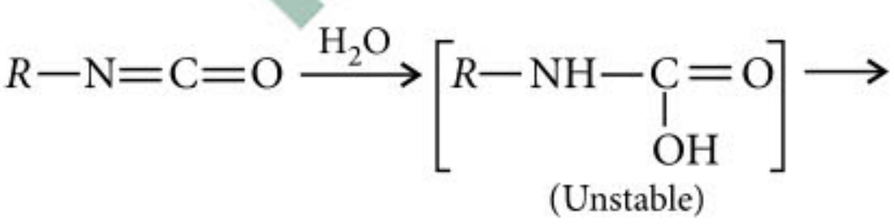
Hydrate of aldehyde

This is generally a reactant favoured equilibrium except a few like chloral, ninhydrin, etc.



Chloral hydrate

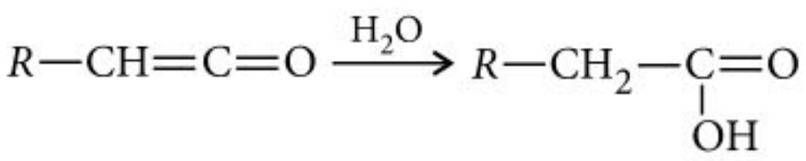
Isocyanate picks water but gets decomposed quickly.



(Unstable)

$$R-NH_2 + CO_2 + H_2O$$

Hydration of ketene gives carboxylic acid.



PRACTICE PAPER

BITSAT

Exam dates : 16th to 31st May 2018

1. At 700 K,the equilibrium constant for the reaction $H_{2(g)} + I_{2(g)} \rightleftharpoons 2HI_{(g)}$ is 54.8. If 0.5 mol/L of $HI_{(g)}$ is present at equilibrium at 700 K, what are the concentrations of $H_{2(g)}$ and $I_{2(g)}$, assuming that only $HI_{(g)}$ was present initially?
(a) 0.0675, 0.0675 (b) 0.0675, 0.0337
(c) 0.0337, 0.0675 (d) 0.0337, 0.0337

2. When MnO_2 is fused with KOH, a coloured compound is formed. Which of the following is the correct pair of compound and its colour?
(a) K_2MnO_4, purple green (b) $KMnO_4$, purple
(c) Mn_2O_3, brown (d) Mn_3O_4, black

3. Which reagent is useful in separating benzoic acid from phenol?
(a) Dil. HCl (b) Dil. H_2SO_4
(c) Conc. H_2SO_4 (d) 5% $NaHCO_3$

4. Which of the following is not correct regarding physical adsorption?
(a) On increasing temperature, it increases continuously.
(b) Its molar enthalpy is low.
(c) This is not specific in nature.
(d) It is reversible in nature.

5. The enthalpy of combustion of carbon to CO_2 is –393.5 kJ mol^{-1}. The heat released upon the formation of 35.2 g of CO_2 from carbon and dioxygen gas is
(a) 4.8×10^2 kJ (b) 3.1×10^2 kJ
(c) 5.9×10^2 kJ (d) 6.7×10^2 kJ.

6. When phosphorous acid is allowed to react with sufficient quantity of KOH, which of the following product is obtained?
(a) K_3PO_3 (b) KH_2PO_3
(c) K_2HPO_3 (d) $KHPO_3$

7. In which of the following species, Cr is in the +3 oxidation state?
(a) CrO_4^{2-} (b) $Cr_2O_7^{2-}$ (c) CrO_2 (d) Cr_2O_3

8. Which of the following will produce a buffer solution when mixed in equal volumes?
(a) 0.1 mol dm^{-3} NH_4OH and 0.1 mol dm^{-3} HCl
(b) 0.05 mol dm^{-3} NH_4OH and 0.1 mol dm^{-3} HCl
(c) 0.1 mol dm^{-3} NH_4OH and 0.05 mol dm^{-3} HCl
(d) 0.1 mol dm^{-3} CH_3COONa and 0.1 mol dm^{-3} NaOH

9. The portion of edge length not occupied by atoms for *scc*, *fcc* and *bcc* are respectively (*a* is edge length)
(a) $0; a\left(1-\frac{\sqrt{3}}{2}\right); a\left(1-\frac{1}{\sqrt{2}}\right)$
(b) $a\left(1-\frac{\sqrt{3}}{2}\right); 0; a\left(2-\frac{1}{\sqrt{2}}\right)$
(c) $0; a\left(1-\frac{1}{\sqrt{2}}\right); a\left(1-\frac{\sqrt{3}}{2}\right)$
(d) $a\,; 2\sqrt{2}\,a\,; \frac{\sqrt{3}}{2}a$

10. Which of the following chlorides cannot be obtained in the anhydrous state by heating the hydrated salt?
(a) $MgCl_2$ (b) $CaCl_2$ (c) $SrCl_2$ (d) $BaCl_2$

11. The following data pertain to a reaction between *A* and *B* :

S.No.	[*A*] (mol L^{-1})	[*B*] (mol L^{-1})	Rate (mol L^{-1} s^{-1})
I	1×10^{-2}	2×10^{-2}	2×10^{-4}
II	2×10^{-2}	2×10^{-2}	4×10^{-4}
III	2×10^{-2}	4×10^{-2}	8×10^{-4}

Which of the following inference(s) can be drawn from the above data?
(i) Rate constant of the reaction is 10^{-4}.
(ii) Rate law of the reaction is $k[A]\,[B]$.
(iii) Rate of reaction increase four times on doubling the concentration of both the reactants.
(a) (i), (ii) and (iii) (b) Only (i) and (ii)
(c) Only (ii) and (iii) (d) Only (iii)

12. Which one would give H_2O_2 on addition of HCl?
(a) MnO_2 (b) PbO_2
(c) BaO (d) None of these

13. The $\Delta_f H°$ for $CO_{2(g)}$, $CO_{(g)}$ and $H_2O_{(g)}$ are –393.5, –110.5 and –241.8 kJ mol^{-1} respectively. The standard enthalpy change (in kJ) for the reaction $CO_{(g)} + H_2O_{(g)} \longrightarrow CO_{2(g)} + H_{2(g)}$ is
(a) 524.1 (b) 41.2 (c) –262.5 (d) –41.2

14. Which of the following compounds can exhibit tautomerism?
(a) C_6H_5CHO (b) $C_6H_5COC(CH_3)_3$
(c) $C_6H_5COCH_2CHO$ (d) $C_6H_5COC_6H_5$

15. The time required to coat a metal surface of 80 cm^2 with 5×10^{-3} cm thick layer of silver (density 1.05 g cm^{-3}) with a passage of 3 A current through a silver nitrate solution is
(a) 115 s (b) 125 s (c) 135 s (d) 145 s

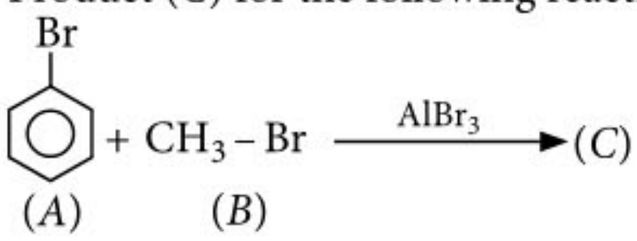
16. Which one of the following statements is true?
(a) In aqueous medium, HF is a stronger acid than HCl.
(b) $HClO_4$ is a weaker acid than $HClO_3$.
(c) HNO_3 is a stronger acid than HNO_2.
(d) H_2PO_3 is a stronger acid than H_2SO_3.

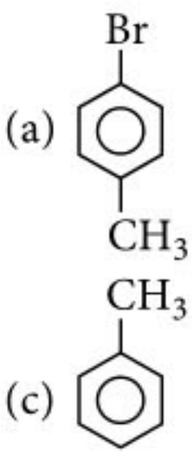
17. Two aqueous solutions *A* and *B*, are separated by a semi-permeable membrane. The osmotic pressure of solution *A* immediately begins to decrease. Which of the following statements is true?
(a) The solvent molecules are moving from the solution of higher osmotic pressure to that of lower osmotic pressure.
(b) The initial osmotic pressure of solution *B* is greater than that of solution *A*.
(c) Solvent molecules are moving from solution *B* into solution *A*.
(d) Both (a) and (b).

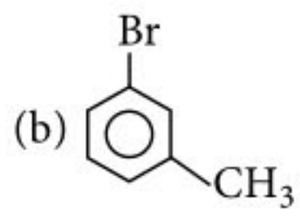
18. Which of the following alkenes is most reactive towards cationic polymerisation?
(a) $CH_2=CHCH_3$ (b) $CH_2=CHCl$
(c) $CH_2=CHC_6H_5$ (d) $CH_2=CHCOOCH_3$

19. Which of the following hybridisations is possible for square planar molecules?
(a) sp^3d (b) dsp^3 (c) dsp^2 (d) sp^3d^2

20. Product (*C*) for the following reaction is



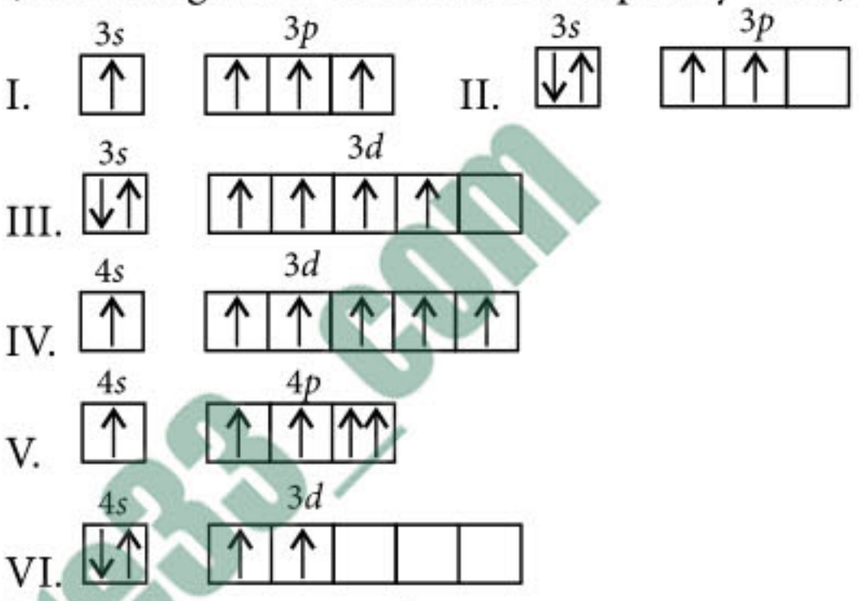
(a) 

(b) 

(c)

(d) none of these.

21. Consider the following six electronic configurations (remaining inner orbitals are completely filled) :



Mark the correct option.
(a) Stability order : V > I > IV > III.
(b) Order of spin multiplicity : IV > III = I > II.
(c) V does not violate all rules of electronic configuration.
(d) If VI represents *A* and when A^+ kept near a magnet, acts as diamagnetic substance.

22. Volatile nature of halogens is because
(a) the halogen molecules are more reactive
(b) the force existing between the molecules are only weak van der Waals' forces
(c) halogen molecules are bounded by strong forces
(d) halogen molecules are bounded by electrostatic forces.

23. Addition of BH_3 to *trans*-2-butene followed by reaction with H_2O_2, would give the product which is
(a) achiral compound (b) racemic mixture
(c) meso compound
(d) optically active compound.

24. Fructose on oxidation with HIO_4 gives
(a) two moles of formaldehyde + four moles of formic acid
(b) two moles of formaldehyde + three moles of formic acid + one mole of carbon dioxide
(c) one mole of formaldehyde + five moles of formic acid
(d) three moles of formaldehyde + three moles of formic acid.

25. Determine the enthalpy of formation of B_2H_6 in kJ/mol of the following reaction :

$B_2H_{6(g)} + 3O_{2(g)} \longrightarrow B_2O_{3(s)} + 3H_2O_{(g)}$

Given : $\Delta_r H° = -1941$ kJ/mol;

$\Delta_f H°\ (B_2O_3, s) = -1273$ kJ/mol;

$\Delta_f H°\ (H_2O, g) = -241.8$ kJ/mol

(a) −75.6 (b) +75.6 (c) −57.4 (d) −28.4

26. Coordination number of Cr is six. A complex with $C_2O_4^{2-}$, ethylene diamine (*en*) and superoxide, O_2^- will be in the ratio to make complex $[Cr(C_2O_4)_x(en)_y(O_2)_z]^-$.

	x	y	z		x	y	z
(a)	1	1	1	(b)	1	1	2
(c)	1	2	2	(d)	2	1	1

27. When propanol is heated with Al_2O_3 at 380 °C, the product obtained is

(a) dipropyl ether (b) propene

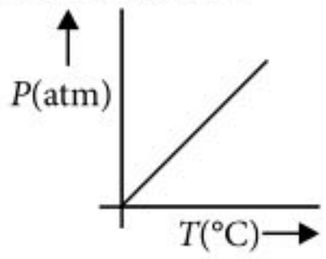
(c) ethene (d) diethyl ether.

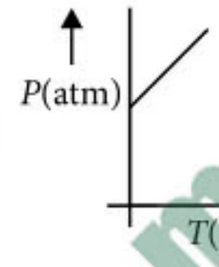
28. The compound which on reaction with aqueous nitrous acid at low temperature produces an oily nitrosoamine is

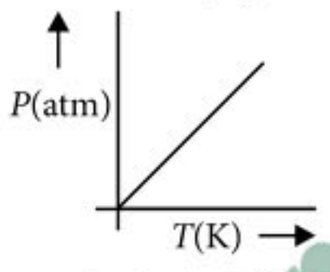
(a) methylamine (b) ethylamine

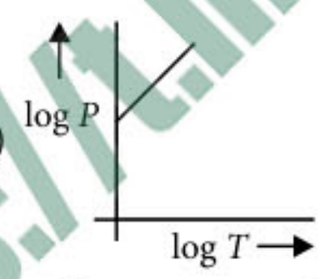
(c) diethylamine (d) triethylamine.

29. Which of the following curve does not represent Gay Lussac's law?

(a) 

(b) 

(c) 

(d) 

30. An explosion takes place when conc. H_2SO_4 is added to $KMnO_4$. Which of the following is formed?

(a) Mn_2O_7 (b) MnO_2 (c) $MnSO_4$ (d) Mn_2O_3

31. When CH_3CHO reacts with excess of HCHO in the presence of a base, which statement is true?

(a) Only aldol-type (Claisen-Schmidt) reaction takes place.

(b) Only Cannizzaro-type (crossed Cannizzaro) reaction takes place.

(c) Both aldol-type and Cannizzaro-type reactions take place.

(d) None of these.

32. $CoCl_2$ gives blue colour with NH_4SCN due to the formation of

(a) $(NH_4)_2[Co(SCN)_4]$ (b) $(NH_4)_4[Co(SCN)_6]$

(c) $(NH_4)_3[Co(SCN)_6]$ (d) $(NH_4)[Co(SCN)_4]$

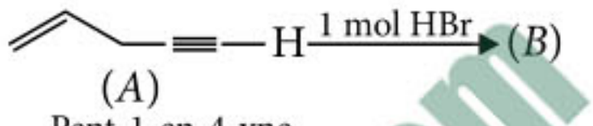
33. The "volume strength" of 1.5 N H_2O_2 solution is

(a) 4.8 (b) 8.4 (c) 3.0 (d) 8.0

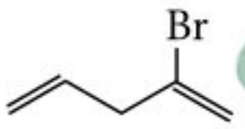
34. Sodium metal is produced commercially by the electrolysis of molten sodium chloride and chlorine is produced as a by product. How many litres of chlorine at 1.8 atm and 27 °C will be produced if a current of 1×10^3 A is passed through $NaCl_{(l)}$ for 9.65 h?

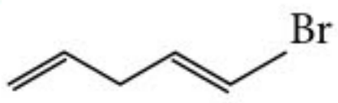
(a) 2463 (b) 460 (c) 1800 (d) 1231.6

35. Identify the product (*B*) in the following reaction.

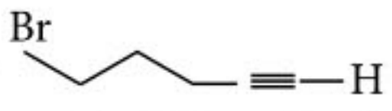


(*A*)
Pent-1-en-4-yne

(a) 

(b) 

(c) 

(d) 

36. The molar masses of oxygen and sulphur dioxide are 32 and 64 respectively. If 1 L of oxygen at 25 °C and 760 mm Hg pressure contains *N* molecules, then the number of molecules in 2 L sulphur dioxide under same conditions of temperature and pressure is

(a) $N/2$ (b) $3N/2$ (c) $2N$ (d) $6N$

37. Which of the following is not a step of Cannizzaro reaction mechanism?

$2PhCHO \xrightarrow{O\bar{H}} PhCH_2OH + PhCOO^-$

(a) The attack of $O\bar{H}$ at the (C = O) group.

(b) The transfer of H^- ion to the (C = O) group.

(c) The abstraction of H^+ ion from carboxylic acid.

(d) The deprotonation of $PhCH_2OH$.

38. The reaction which proceeds in the forward direction is

(a) $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$

(b) $NH_3 + H_2O + NaCl \longrightarrow NH_4Cl + NaOH$

(c) $2CuI + I_2 + 4H^+ \longrightarrow 2Cu^{2+} + 4HI$

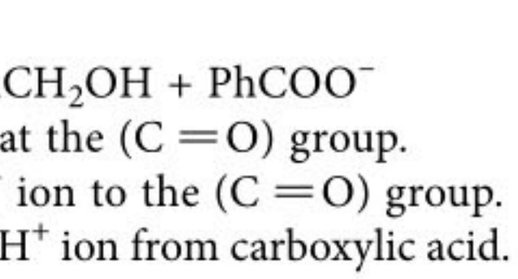
(d) both (b) and (c).

39. The first ionisation enthalpies of Na, Mg, Al and Si are in the order

(a) Na < Mg > Al < Si (b) Na > Mg > Al > Si

(c) Na < Mg < Al < Si (d) Na > Mg > Al < Si

40. If optical rotation produced by the compound (I) is +52° then optical rotation produced by the compound (II) will be



(a) $-52°$ (b) $+52°$
(c) $0°$ (d) unpredictable.

SOLUTIONS

1. (a) : At equilibrium, the concentrations of H_2 and I_2 would be equal. Let the equilibrium concentrations of H_2 and I_2 be x mol/L.

$$\text{Then, } K_c = \frac{[HI]^2}{[H_2][I_2]} \Rightarrow \frac{(0.5)^2}{x^2} = 54.8$$

$$\Rightarrow x^2 = \frac{(0.5)^2}{54.8} \Rightarrow x = 0.0675 \text{ mol/L}$$

Thus, the equilibrium concentrations of H_2 and I_2 are 0.0675 mol/L each.

2. (a) : $2MnO_2 + 4KOH + O_2 \longrightarrow \underset{\text{Purple green}}{2K_2MnO_4} + 2H_2O$

3. (d) : 5% $NaHCO_3$ reacts with benzoic acid and gives effervescences with the evolution of CO_2 whereas phenol does not react.

4. (a) : On increasing temperature, physical adsorption decreases continuously.

5. (b) : $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$; $\Delta H_c = -393.5$ kJ mol^{-1}

$$\text{No. of moles in 35.2 g } CO_2 = \frac{35.2 \text{ g}}{44 \text{ g/mol}} = 0.80 \text{ mol}$$

Formation of 1 mol of CO_2 releases 393.5 kJ of heat.
$\therefore$ Formation of 0.80 mol of CO_2 releases
$= 0.80 \times 393.5$ kJ $= 3.1 \times 10^2$ kJ of heat.

6. (c) : $H_3PO_3 + 2KOH \longrightarrow K_2HPO_3 + 2H_2O$

7. (d) : Cr_2O_3
$2x + 3(-2) = 0 \Rightarrow 2x = +6 \Rightarrow x = +3$

8. (c) : In option (c), all HCl will be neutralized and NH_4Cl will be formed. Also some NH_4OH will be left unneutralized. Thus, the final solution will contain NH_4OH and NH_4Cl and it will form a buffer.

9. (c) : For simple cubic, distance between nearest neighbours = a
Empty space = 0
For *fcc*, distance between nearest neighbours, $d = \frac{a}{\sqrt{2}}$

$$\text{Empty space} = a - \frac{a}{\sqrt{2}} = a\left(1 - \frac{1}{\sqrt{2}}\right)$$

$$\text{For } bcc, d = \frac{\sqrt{3}a}{2}$$

$$\text{Empty space} = a - \frac{\sqrt{3}a}{2} = a\left(1 - \frac{\sqrt{3}}{2}\right)$$

10. (a) : $MgCl_2.6H_2O \xrightarrow{\Delta} Mg(OH)Cl + HCl + 5H_2O$
$\downarrow$
$MgO + HCl$

11. (c) : To find the order w.r.t. A, from I and II.

$$\frac{1\times10^{-2}}{2\times10^{-2}} = \frac{2\times10^{-4}}{4\times10^{-4}} \Rightarrow \frac{1}{2} = \frac{1}{2} \Rightarrow \text{order} = 1$$

To find the order w.r.t. B, from II and III.

$$\frac{2\times10^{-2}}{4\times10^{-2}} = \frac{4\times10^{-4}}{8\times10^{-4}} \Rightarrow \frac{1}{2} = \frac{1}{2} \Rightarrow \text{order} = 1$$

$\therefore$ Rate law of the reaction is $k[A]\,[B]$.
From I, $r = k[A]\,[B]$

$$k = \frac{r}{[A][B]} = \frac{2\times10^{-4}}{(1\times10^{-2})(2\times10^{-2})} \Rightarrow k = 1$$

From the rate law expression, $r = k[A][B]$
on doubling the concentrations of both the reactants,
$r_1 = k[2A][2B]$, $r_1 = 4k[A][B]$, $r_1 = 4r$

12. (d) : None of the oxides is a peroxide, hence would not give H_2O_2.

13. (b) : $\Delta_f H^\circ = \Delta_f H^\circ (CO) + \Delta_f H^\circ (H_2O) - \Delta_f H^\circ(CO_2) - \Delta_f H^\circ (H_2)$
$= -110.5 + (-241.8) - (-393.5) - 0 = 41.2$ kJ/mol

14. (c) : The carbonyl compounds containing atleast one α-hydrogen atom undergo tautomerism. Hence, among the given compounds, $C_6H_5COCH_2CHO$ can exhibit tautomerism.

15. (b) : Mass of Ag required $= 80 \times 5 \times 10^{-3} \times 1.05 = 0.42$ g

$$\because\ w = \frac{ZIt}{96500} \quad \therefore\ 0.42 = \frac{108\times3\times t}{96500} \Rightarrow t = 125 \text{ s}$$

16. (c) : The order of acidic strength is :
$HCl > HF$; $HClO_4 > HClO_3$; $HNO_3 > HNO_2$;
$H_2SO_3 > H_2PO_3$

17. (c) : Solvent molecules are moving from solution B into solution A hence, osmotic pressure of solution A immediately begins to decrease.

18. (c) : In cationic polymerisation, carbocations are formed. Greater the stability of the carbocation, more reactive is the alkene. Since, the stability of the intermediate carbocation follows the order :

$CH_3\overset{+}{C}HC_6H_5 > CH_3\overset{+}{C}HCH_3 > CH_3\overset{+}{C}HCl >$
$CH_3\overset{+}{C}HCOOCH_3$

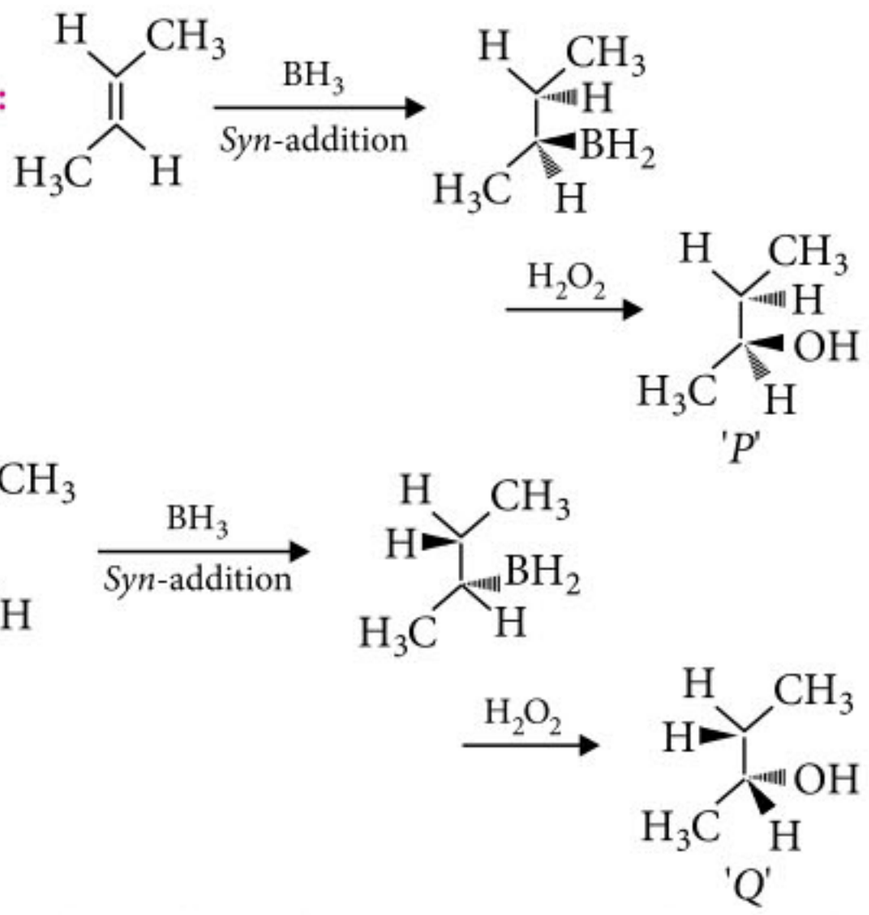
Therefore, reactivity decreases in the same order. Thus, styrene is most reactive.

19. (c) **20. (a)**

21. (b) : (b) : Spin multiplicity $= 2S + 1$
For IV : $2S + 1 = 7$; III : $2S + 1 = 5$; I : $2S + 1 = 5$;
II : $2S + 1 = 3$
(c) V Violate Hund's rule.
(d) A^+ when kept near a magnet, it acts as a paramagnetic substance due to presence of unpaired electrons.

22. (b)

23. (b):



P and *Q*, thus obtained are enantiomers hence, the overall product is racemic mixture.

24. (b): $CH_2OH-CO-(CHOH)_3CH_2OH \xrightarrow{HIO_4}$

Fructose

$HCHO + HOOC-(CHOH)_3-CH_2OH \xrightarrow{HIO_4}$

$OHC-(CHOH)_2-CH_2OH + CO_2 \xrightarrow{HIO_4}$

$HCO_2H + OHC-CHOH-CH_2OH \xrightarrow{HIO_4}$

$HCO_2H + OHC-CH_2OH \xrightarrow{HIO_4} HCO_2H + HCHO$

25. (c): $\Delta_rH^\circ = \{\Delta_fH^\circ(B_2O_3) + 3\Delta_fH^\circ(H_2O)\} - \Delta_fH^\circ(B_2H_6)$

$-1941 = -1273 + 3(-241.8) - \Delta_fH^\circ(B_2H_6)$

$(\Delta_fH^\circ)B_2H_6 = -1273 - 725.4 + 1941 = -57.4$ kJ/mol

26. (b): $C_2O_4^{2-}$ and *en* are bidentate ligands.

C.N. of $Cr^{3+} = 6$, So, $x = 1$, $y = 1$, $z = 2$

Sum of charges = Net charge

$+3 + (-2 \times x) + 0(y) + (-1 \times z) = -1$

$\therefore \quad +3 + (-2) + 0 + (-1 \times 2) = -1$

Thus, the complex will be $[Cr(C_2O_4)(en)(O_2)_2]^-$.

27. (b): $CH_3-CH_2-CH_2-OH \xrightarrow[380\ ^\circ C]{Al_2O_3}$

Propanol

$CH_3-CH=CH_2 + H_2O$

Propene

28. (c): 2° amines react with HNO_2 at low temperature to give oily nitrosoamine.

$Et_2NH + HNO_2 \longrightarrow Et_2N-N=O + H_2O$

N-Nitrosodiethylamine

29. (a)

30. (a): $2KMnO_4 + H_2SO_4 \longrightarrow$

$Mn_2O_7 + K_2SO_4 + H_2O$

(Explosive)

31. (c): $CH_3-CHO + HCHO \xrightarrow[\text{Aldol type reaction}]{\text{Base}}$

$HO-CH_2-CH_2-CHO \xrightarrow{\Delta}$

$CH_2=CH-CHO$

α, β-unsaturated aldehyde

$HCHO + HCHO \xrightarrow[\text{Cannizaro reaction}]{\text{Base}}$

$HCOOH + CH_3OH$

32. (a)

33. (b): Volume strength = 5.6 × Normality

$= 5.6 \times 1.5 = 8.4$

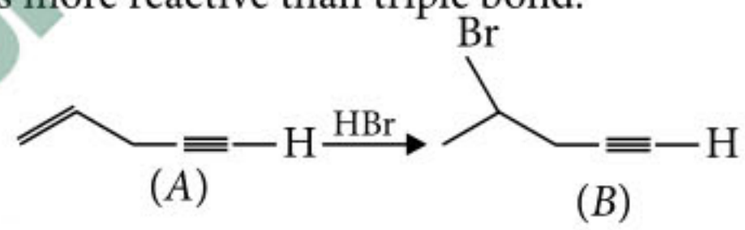
34. (a): Equivalents of Cl_2 produced

$$= \frac{1000 \times 9.65 \times 3600}{96500} = 360$$

Moles of $Cl_2 = 180$

Now, $V = \frac{nRT}{P} \Rightarrow \frac{180 \times 0.0821 \times 300}{1.8} = 2463$ L

35. (c): In the given compound, electrophilic addition of 1 mol of HBr takes place at double bond, as double bond is more reactive than triple bond.



36. (c): $PV = nRT$

$P = 760$ mmHg $= 1$ atm

Moles of $O_2 = \frac{PV}{RT} = \frac{1 \times 1}{RT}$

$\therefore$ No. of molecules $(N) = \frac{N_0}{RT}$ ...(i)

Moles of $SO_2 = \frac{PV}{RT} = \frac{1 \times 2}{RT}$

$\therefore$ No. of molecules $(M) = \frac{2N_0}{RT}$ ...(ii)

Dividing both eq. we get, $\frac{N}{M} = \frac{1}{2} \Rightarrow M = 2N$

37. (d)

38. (a): $Fe_2O_3 + 6HCl \longrightarrow 2FeCl_3 + 3H_2O$

Backward reaction will not take place due to the lack of hydrolysis of $FeCl_3$.

39. (a): $Na(3s^1) < Mg(3s^2) > Al(3s^23p^1) < Si(3s^23p^2)$

40. (a): Two given compounds are enantiomers *i.e.*, non-superimposable mirror image of each other which rotate the plane polarised light by same angle but in opposite direction *i.e.*, if one rotates by +52° then another compound rotates by –52°.

CONCEPT BOOSTER

Dear Students! Thanks a lot for your response to the last article. This article is in continuation with the last article, some problems are given at the end of this article which will help you to better understand the topic. Do read carefully and smartly. Stay healthy, all the best.

*Arunava Sarkar

A BRIEF OVERVIEW OF ORGANOMETALLIC REAGENTS AND ORGANOMETALLIC CHEMISTRY

ORGANOCOPPER COMPOUNDS

❍ Organocopper compounds are very important reagents in many synthesis reactions. The most widely used organocopper reagents are given by a general formula R_2CuLi and are called lithium organocuprates or lithium dialkylcuprates. The general preparation strategy is :

$$R - X \xrightarrow{2Li} R - Li + LiX$$

$$2R - Li + CuI \longrightarrow \underset{\substack{\text{Lithium}\\ \text{dialkyl}\\ \text{cuprate}}}{R_2CuLi} + LiI$$

Organocopper reagents are usually referred to as Gilman reagents. Organocopper reagents are comparatively less stable and therefore, they are prepared in situ. These reagents are chemoselective in nature. Organocopper reagents are particularly useful in transmetallating Grignard reagents.

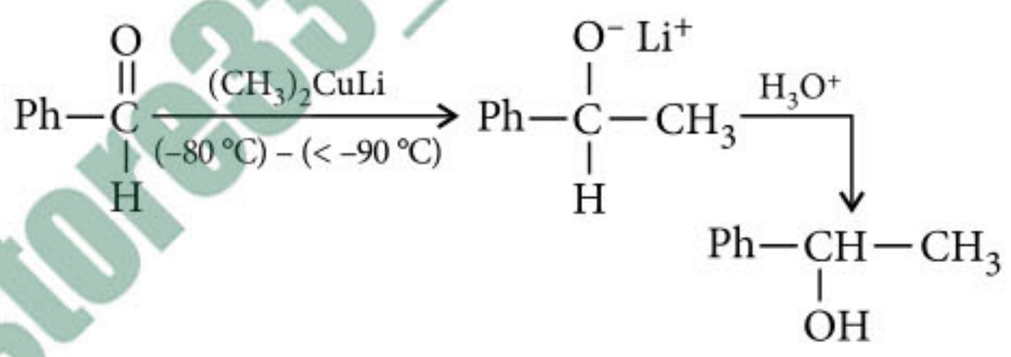
$$CH_3MgBr \xrightarrow[\text{Transmetallation}]{CuCl} CH_3Cu + MgBrCl$$

Now, Let us take an overlook on the major reactions exhibited by organocopper compounds :

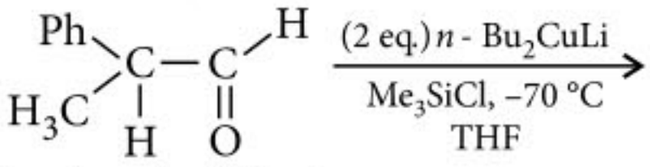
❍ Reactions with aldehydes and ketones

At the beginning be informed that organocuprate reacts conveniently with aldehydes but quite sluggishly with ketones. On an average, it is found that organocuprates react at around – 70 °C with aldehydes to give products via *anti*-and *syn*-addition where the *anti*-addition product is found to be the major one.

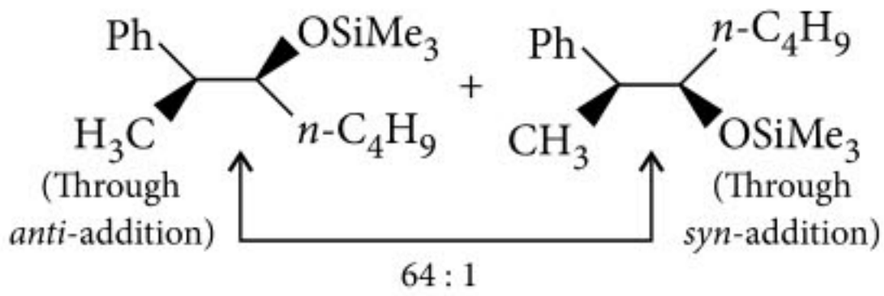
Take a few examples :



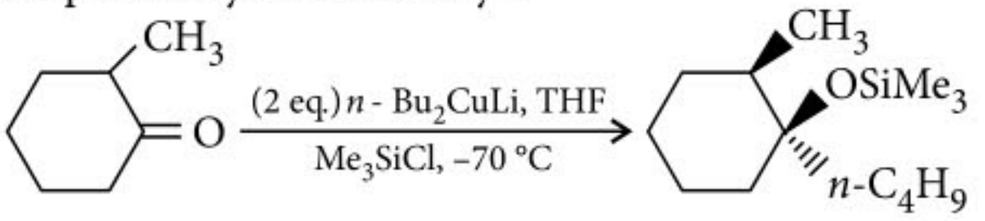
Sometimes, chlorotrimethyl silane is used along with lithium dialkylcuprates.



2-Phenylpropionaldehyde



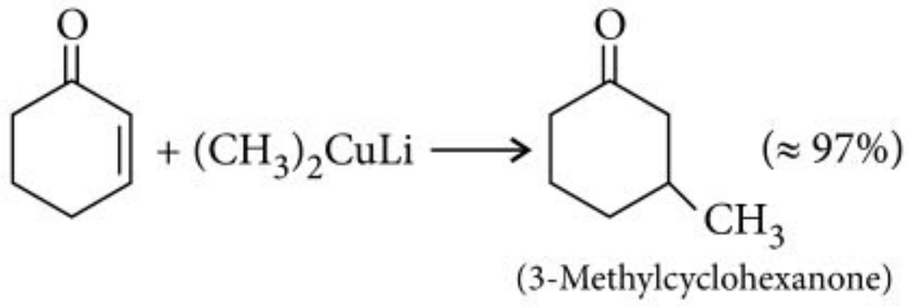
The following reaction with ketone is found to occur comparatively conveniently :



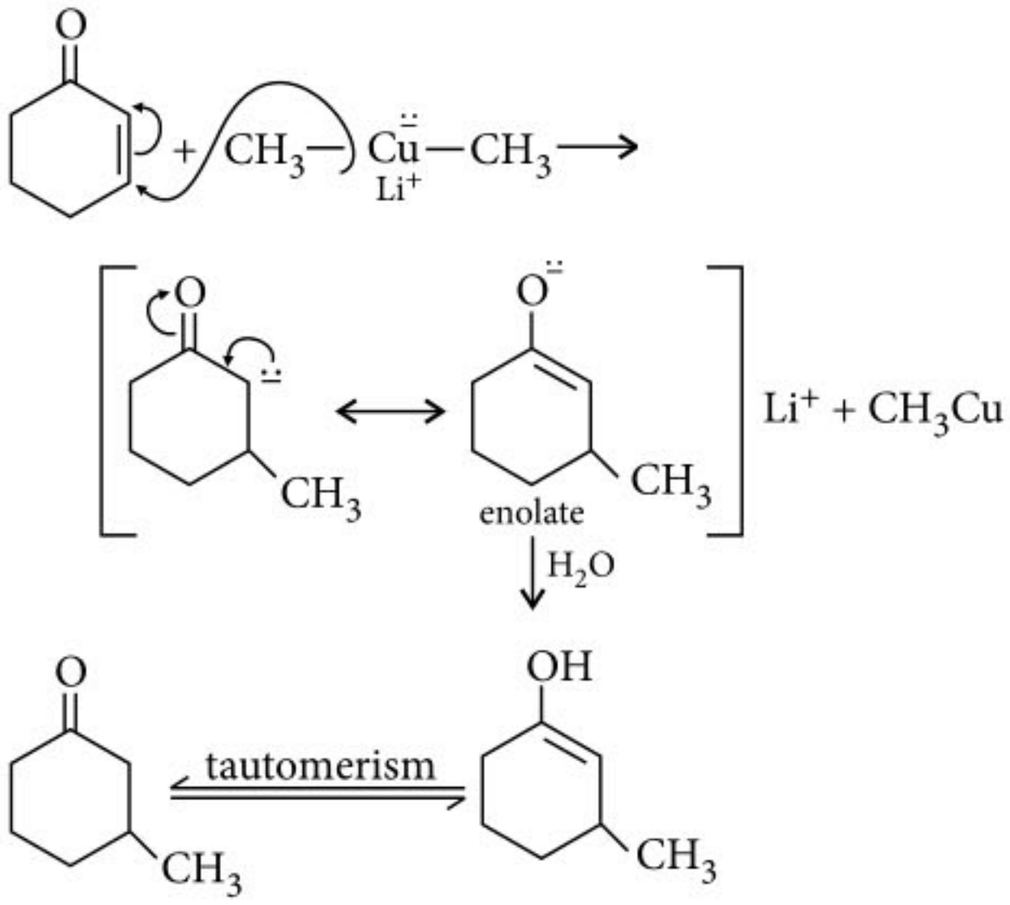
❍ Reactions with α, β-unsaturated carbonyl compounds

Exclusively 1,4-addition product (conjugate addition) is obtained. Let us take the example of the reaction between lithium dialkyl cuprate with cyclohexen-2-one.

*Institute of Chemistry (IOC)- Asansol, Durgapur, Dhanbad, Burdwan, Kolkata, Jamshedpur, Bokaro, Patna

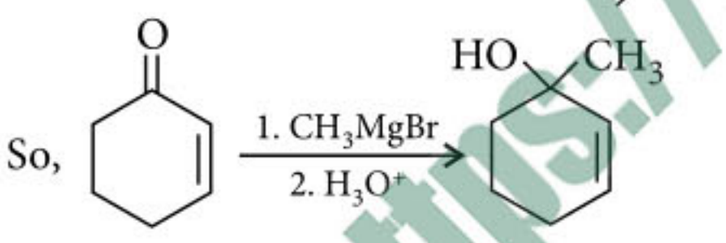


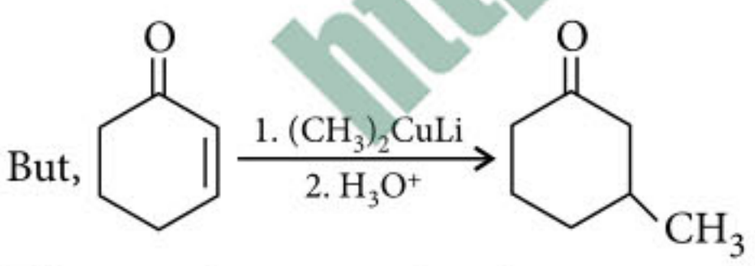
Mechanism :



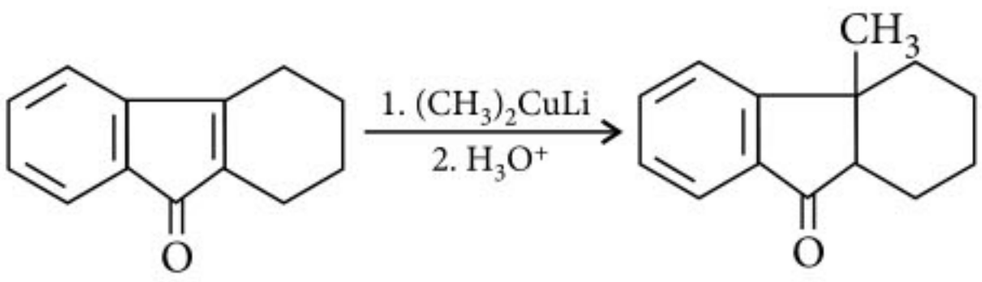
Now, a question comes that, why organocopper reagents undergo addition in conjugate fashion?

Actually, copper is less electropositive than magnesium and it attacks softer $\rangle C=C\langle$ bond which is considered to be an 'inferior' bond or unstable bond in comparison to $\rangle C=O$ bond, whereas Grignard reagent attack a 'better' bond or stable bond *i.e.*, $\rangle C=O$.



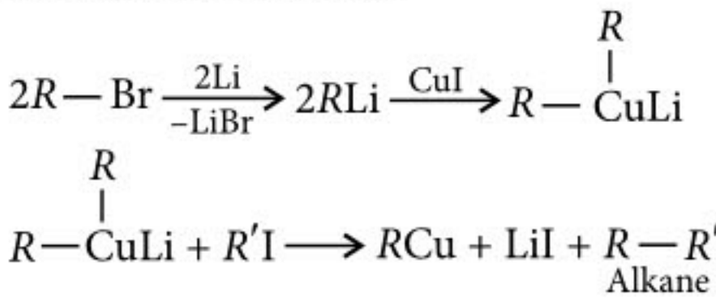


Take another example where you will understand the synthetic application of using organocopper compounds.

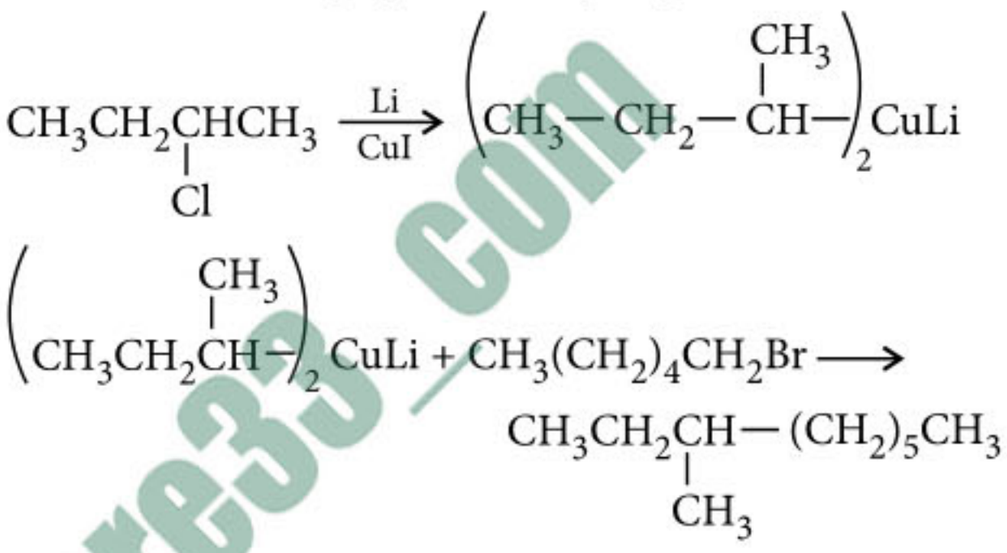


❍ Reaction with alkyl and aryl halide

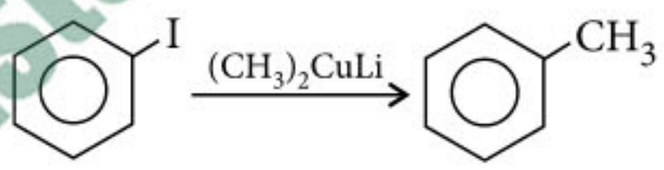
These reactions are well known as the coupling reactions. Preparation of alkane through this reagent is better known as Corey-House synthesis and is usually carried out as below :



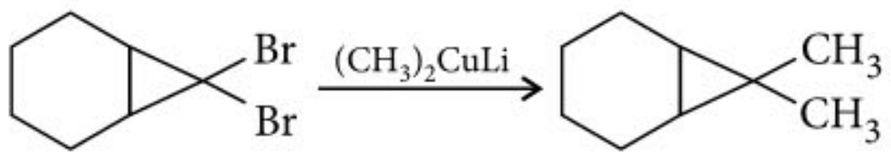
Take the following synthetically important reaction :



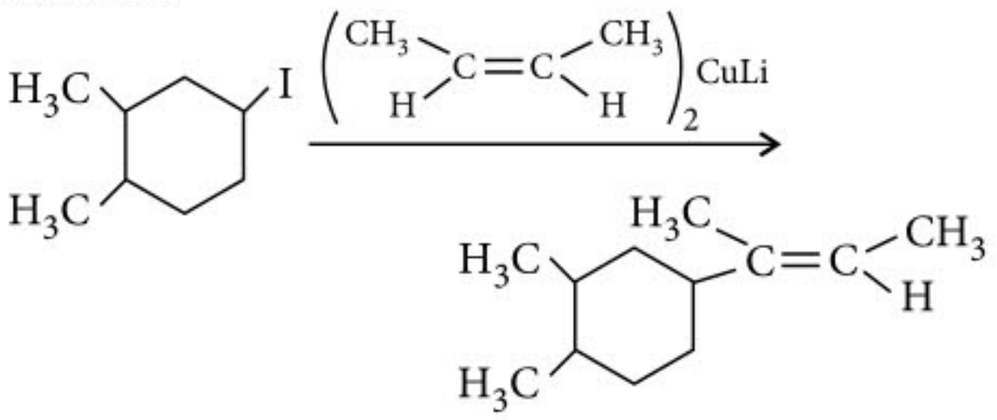
with aryl halides, replacement of halogen takes place *via* the alkyl group of lithium dialkyl cuprate.



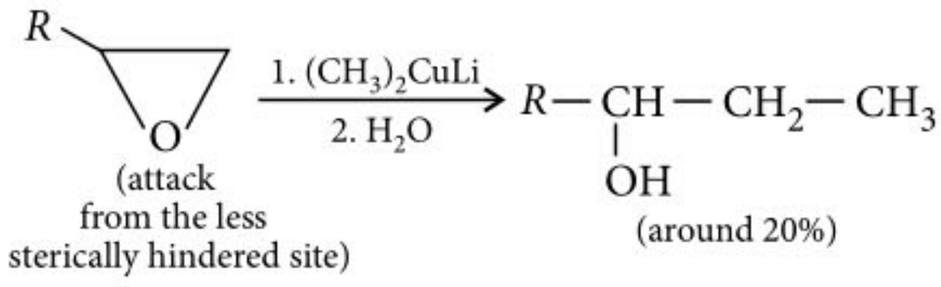
Double halogen substitution is also visible with alicyclic ring :



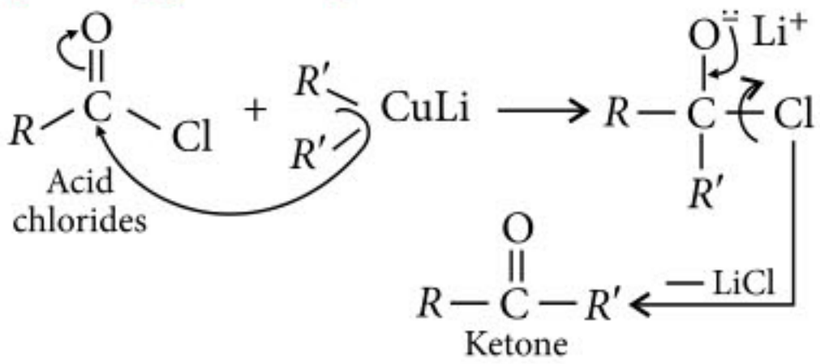
You can also replace a halogen atom with an alkene skeleton.



❍ Reaction with Epoxide



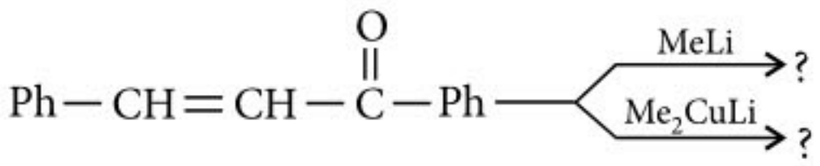
❍ Reaction with acid chlorides and chemoselectivity of organocopper compounds.



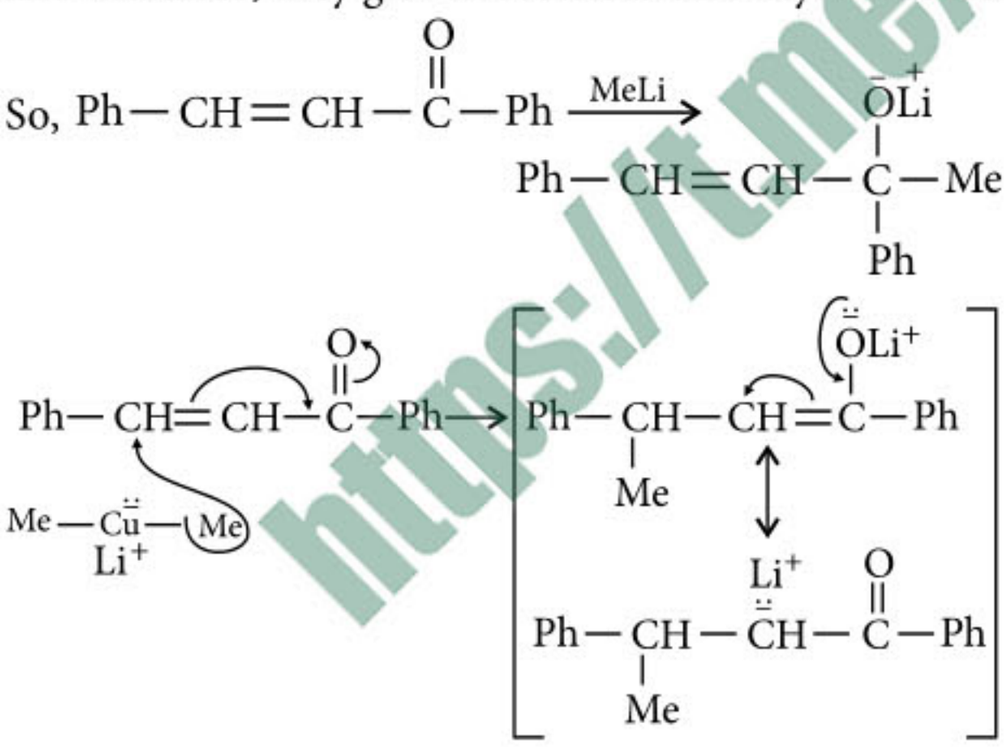
Would it have been Grignard reagent, a further reaction with ketone takes place to give 3° alcohol. But, here the case is NOT similar. Due to lower reactivity, organocopper reagents do not react further. Remember that in many cases organocopper reagents show chemoselectivity with $-NO_2$, $-CN$, $-COOR$, $-CO-$ etc., Grignard reagents and organolithium reagents react with these functional groups but organocopper compounds DO NOT.

PRACTICE PROBLEMS

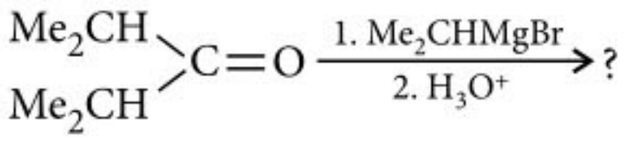
1. Identify the products :



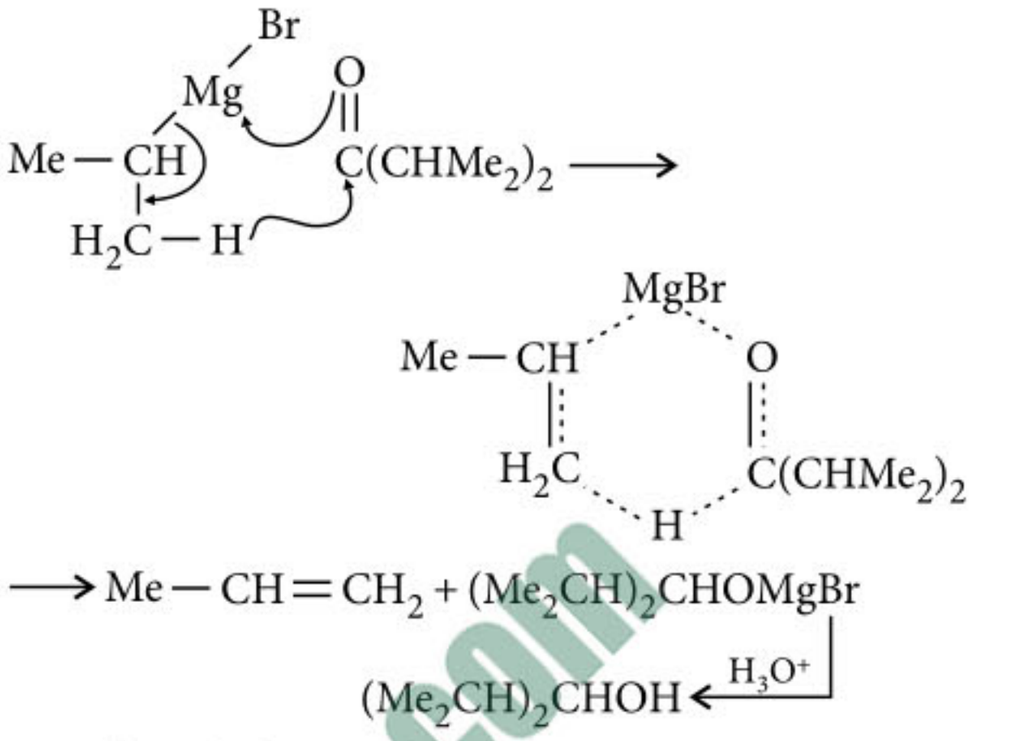
Soln : Here, carbonyl addition will take place with MeLi and conjugate addition will take place with Me_2CuLi. Organolithium reagents are very powerful nucleophiles and therefore, they give irreversible carbonyl addition.



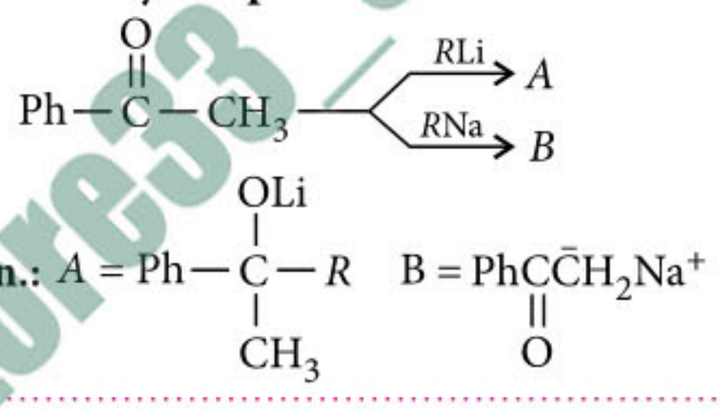
2. Identify the product :



Soln : When the alkyl group of Grignard reagent is very large and the groups attached with the carbonyl carbon of ketone are also very large rather branched then in that case normal addition reaction doesn't take place. In that case, if the Grignard reagent contains β-hydrogen then reduction takes place. The reaction scenario is as below :



3. Identify the products :



EXAM CORNER 2018

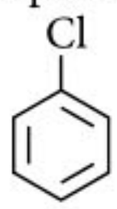
Exam	Date
VITEEE	4th to 15th April
JEE Main	8th April (Offline), 15th & 16th April (Online)
SRMJEEE	16th to 30th April
Karnataka CET	18th & 19th April
WBJEE	22nd April
Kerala PET	23rd & 24th April
NEET	6th May
MHT CET	10th May
COMEDK (Engg.)	13th May
AMU (Engg.)	13th May (Revised)
BITSAT	16th to 31st May
JEE Advanced	20th May
AIIMS	27th May
JIPMER	3rd June

PRACTICE PAPER

AIIMS

Exam on 27th May 2018

1. Which one of the following does not give white precipitate with acidified silver nitrate solution?

(a) 

(b) $CH_2=CH-Cl$

(c) $CH_2=CH-CH_2-Cl$ (d) Both (a) and (b)

2. In the following reaction,

$$\underset{(A)}{[Cu(H_2O)_4]^{2+}_{(aq)}} + \underset{(B)}{HCO_3^-{}_{(aq)}} \rightleftharpoons \underset{(C)}{[Cu(H_2O)_3OH]^+_{(aq)}} + \underset{(D)}{H_2CO_{3(aq)}}$$

Species behaving as Bronsted-Lowry acids are

(a) *A*, *B* (b) *B*, *C* (c) *A*, *D* (d) *B*, *D*

3. Calculate Λ^{∞}_{AcOH} using given molar conductances of the electrolytes at infinite dilution in H_2O at 25 °C.

Electrolyte	KCl	KNO_3	HCl	NaOAc	NaCl
Λ^{∞} ($S\ cm^2\ mol^{-1}$)	149.9	145.0	426.2	91.0	126.5

(a) 517.2 (b) 552.7

(c) 390.7 (d) 217.5

4. $CH_3CHO + 3HCHO \xrightarrow[I]{OH^-} (CH_2OH)_3CCHO$

$$\xrightarrow[II]{OH^-} (CH_2OH)_4C + (CH_2OH)_3CCOO^-$$

Reactions at stages I and II are respectively

(a) Cannizzaro, aldol (b) aldol, aldol

(c) Cannizzaro, Cannizzaro

(d) aldol, Cannizzaro.

5. The AsF_5 molecule is trigonal bipyramidal. The hybrid orbitals used by As atom for bonding are

(a) $d_{x^2-y^2}$, d_{z^2}, *s*, p_x, p_y (b) d_{xy}, *s*, p_y, p_z

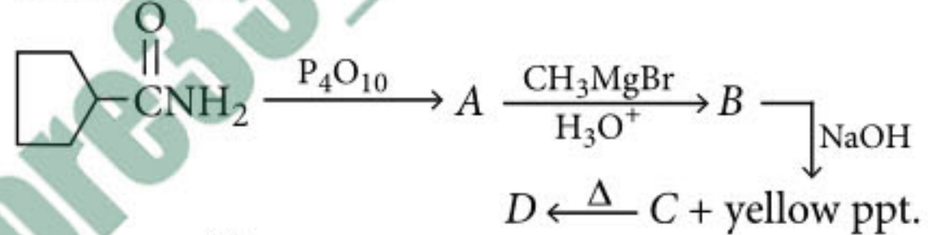
(c) *s*, p_x, p_y, p_z, d_{z^2} (d) $d_{x^2-y^2}$, *s*, p_x, p_y, p_z.

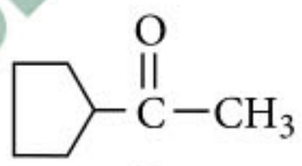
6. The rate expression for the reaction, $A_{(g)} + B_{(g)} \rightarrow C_{(g)}$ is rate $= kC_A^2C_B^{1/2}$. What changes in the initial concentrations of *A* and *B* will cause the rate of reaction to increase by a factor of eight?

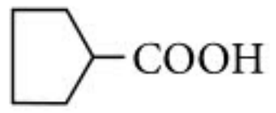
(a) $C_A \times 2$; $C_B \times 2$ (b) $C_A \times 2$; $C_B \times 4$

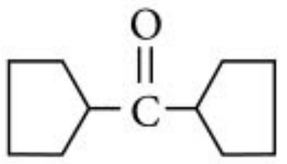
(c) $C_A \times 1$; $C_B \times 4$ (d) $C_A \times 4$; $C_B \times 1$

7. Identify the product (*D*) in the given sequence of reactions.



(a) 

(b) 

(c) 

(d) 

8. The ion(s) that act(s) as oxidizing agent in solution is/are

(a) Tl^+ and Al^{3+} (b) B^{3+} and Al^{3+}

(c) Tl^{3+} only (d) B^{3+} only.

9. The emf of a Daniell cell at 298 K is E_1,

$Zn \mid ZnSO_4(0.01\ M) \parallel CuSO_4\ (1.0\ M) \mid Cu$.

When the concentration of $ZnSO_4$ is 1.0 M and that of $CuSO_4$ is 0.01 M, the emf changed to E_2. What is the relationship between E_1 and E_2?

(a) $E_1 - E_2 = 0.0591$ (b) $E_1 - E_2 = 0.0591 \times 2$

(c) $E_1 - E_2 = \log 10^{-2}$ (b) $E_1 - E_2 = \log 100$

10. An amine forms salt with BF_3 as,

Amine + $BF_3 \rightarrow$ [Amine $\rightarrow BF_3$].

If the alkyl group in amine is $-CH_3$, the order of basicity towards BF_3 is

(a) $CH_3NH_2 > (CH_3)_2NH > (CH_3)_3N$

(b) $(CH_3)_3N > (CH_3)_2NH > CH_3NH_2$

(c) $(CH_3)_2NH > CH_3NH_2 > (CH_3)_3N$

(d) $(CH_3)_2NH > (CH_3)_3N > CH_3NH_2$

11. Which of the following metals burns in air at high temperature with the evolution of much heat?
(a) Cu (b) Hg
(c) Pb (d) Al

12. The monomer that undergoes radical polymerisation most easily is
(a) $CH_2=CH_2$ (b) $C_6H_5CH=CH_2$
(c) $CH_2=C(Me)(Me)$ (d) $CH_3-CH=CH_2$

13. The increasing order of the strength of hydrogen bond in the following mentioned linkages is
(i) O—H ···· S (ii) S—H ···· O
(iii) F—H ···· F (iv) F—H ···· O
(a) (i) < (ii) < (iv) < (iii) (b) (ii) < (i) < (iv) < (iii)
(c) (i) < (ii) < (iii) < (iv) (d) (ii) < (i) < (iii) < (iv)

14. The predominant product formed when 3-methyl-2-pentene reacts with HOCl is

(a) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle Cl}{\underset{|}{\overset{|}{C}}}}-\underset{\displaystyle H}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-CH_2-CH_3$

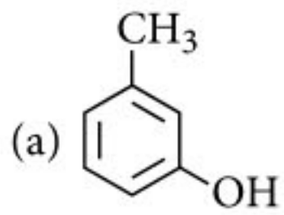
(b) $CH_3-\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{C}}}}-\underset{\displaystyle H}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-CH_3$

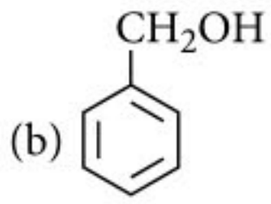
(c) $CH_3-CH_2-\underset{\displaystyle CH_3}{\overset{\displaystyle Cl}{\underset{|}{\overset{|}{C}}}}-\underset{\displaystyle H}{\overset{\displaystyle Cl}{\underset{|}{\overset{|}{C}}}}-CH_3$

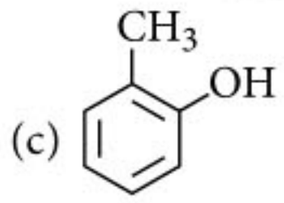
(d) $CH_3-CH_2-\underset{\displaystyle CH_3Cl}{\overset{\displaystyle OH}{\underset{|}{\overset{|}{C}}}}-\underset{\displaystyle H}{\underset{|}{C}}-CH_3$

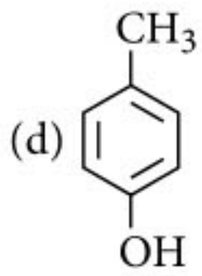
15. The rate law for the reaction,
$R\text{Cl} + \text{NaOH}_{(aq)} \rightarrow R\text{OH} + \text{NaCl}$
is given by, Rate = $k[R\text{Cl}]$. The rate of the reaction will be
(a) doubled on doubling the concentration of sodium hydroxide
(b) halved on reducing the concentration of alkyl halide to one half
(c) decreased on increasing the temperature of reaction
(d) unaffected by increasing the temperature of the reaction.

16. The structure of the compound that gives a tribromoderivative on treatment with bromine water is

(a) 

(b) 

(c) 

(d) 

17. Two solutions of KNO_3 and CH_3COOH are prepared separately. The molarity of both is 0.1 M and osmotic pressures are P_1 and P_2, respectively. The correct relationship between the osmotic pressures is
(a) $P_2 > P_1$ (b) $P_1 = P_2$
(c) $P_1 > P_2$ (d) $\frac{P_1}{P_1+P_2} = \frac{P_2}{P_1+P_2}$

18. Aniline is treated with $NaNO_2/HCl$ at 0 °C to give compound *X* which on treatment with cuprous cyanide gives another compound *Y*. When compound *Y* is treated with H_2/Ni, compound *Z* is obtained. Compound *Z* is
(a) benzyl alcohol (b) benzylamine
(c) *N*-ethylaniline (d) phenol.

19. The ratio of the volume of a tetragonal lattice unit cell to that of a hexagonal lattice unit cell is (both having same respective lengths)
(a) $\frac{\sqrt{3}}{2}abc$ (b) $\frac{2}{3\sqrt{3}}$ (c) $\frac{2}{\sqrt{3}}\frac{a^2c}{b}$ (d) 1

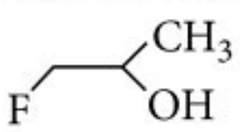
20. Pressure of real gas is less than the pressure of ideal gas because
(a) no. of collisions are more in real gases
(b) of definite shape of molecule of real gases
(c) *K.E.* of molecules in real gases is more
(d) the intermolecular forces in real gases are less.

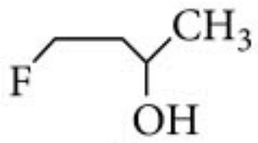
21. In a mixture of PbS, ZnS and FeS each component is separated from other by using the reagents in which of the following sequence in froth floatation process?
(a) Potassium ethyl xanthate, KCN
(b) Potassium ethyl xanthate, KCN, NaOH, $CuSO_4$, acid
(c) KCN, $CuSO_4$, acid (d) None of these

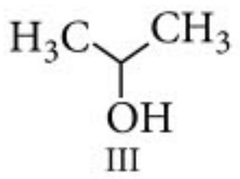
22. Alkali metal + $N_2 \xrightarrow{\Delta} (Q) \xrightarrow{H_2O} (R) + (S)$
(P)
(R) and (S) both react with HCl, but only (S) gives white fumes with HCl. Identify (R).

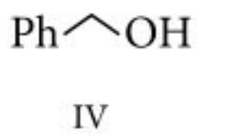
(a) NaOH (b) KOH
(c) LiOH (d) CsOH

23. The order of reactivity of the following alcohols towards conc. HCl is


I

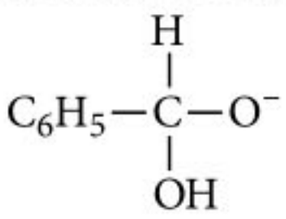

II

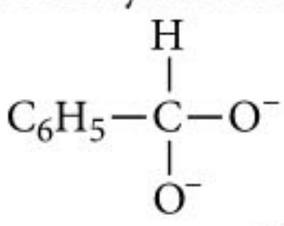

III

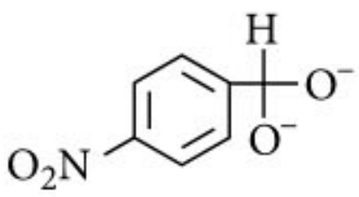

IV

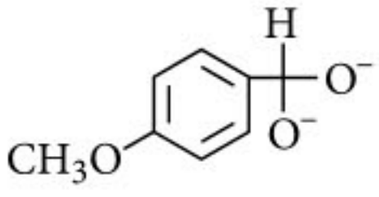
(a) I > II > III > IV (b) IV > II > III > I
(c) IV > III > II > I (d) IV > III > I > II

24. The intermediate which is the best hydride donor is

(a) 

(b) 

(c) 

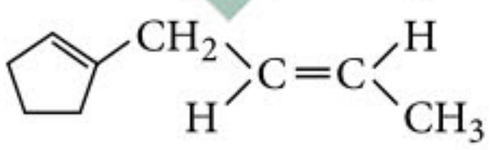
(d) 

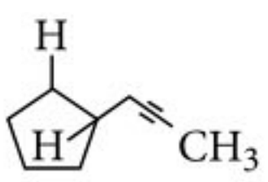
25. To which orbit, the electron in the hydrogen atom will jump on absorbing 12.1 eV of energy?
(a) II orbit (b) III orbit (c) IV orbit (d) V orbit

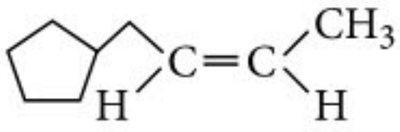
26. $[NiCl_2\{P(C_2H_5)_2(C_6H_5)\}_2]$ exhibits temperature dependent magnetic behaviour. The coordination geometries of Ni^{2+} in the paramagnetic and diamagnetic states are respectively
(a) tetrahedral and tetrahedral
(b) square planar and square planar
(c) tetrahedral and square planar
(d) square planar and tetrahedral.

27. Find the product, *M* for the following reaction :

(a) 

(b) 

(c) 

(d) 

28. Bleeding is stopped by the application of ferric chloride. This is because
(a) the blood starts flowing in opposite direction
(b) the blood reacts and forms a solid, which seals the blood vessel
(c) the blood is coagulated and thus the blood vessel is sealed
(d) the ferric chloride seals the blood vessel.

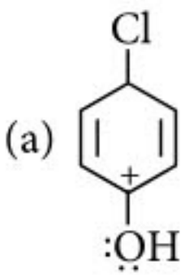
29. A compound contains atoms *A*, *B* and *C*. The oxidation number of *A* is +2, of *B* is +5 and of *C* is –2. The possible formula of the compound is
(a) ABC_2 (b) $B_2(AC_3)_2$
(c) $A_3(BC_4)_2$ (d) $A_3(B_4C)_2$

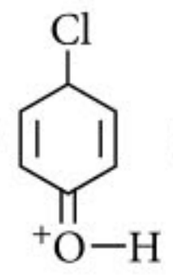
30. A 5 litre cylinder contained 10 mol oxygen gas at 27 °C. Due to sudden leakage through the hole, all the gas escaped into the atmosphere and the cylinder got empty. If the atmospheric pressure is 1.0 atm, what is the work done by the gas?
($R = 0.083$ L-atm mol^{-1} K^{-1})
(a) +241 L-atm (b) –482 L-atm
(c) –241 L-atm (d) +600 L-atm

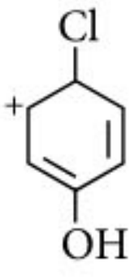
31. van't Hoff factors of aqueous solutions of *X*, *Y* and *Z* are 2.8, 1.8, and 3.5, respectively. Which of the following is correct?
(a) Boiling point : $X < Y < Z$
(b) Freezing point : $Z < X < Y$
(c) Osmotic pressure : $X = Y = Z$
(d) Vapour pressure : $Y < X < Z$

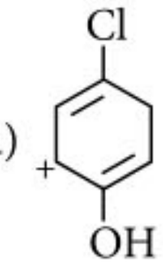
32. Of the options given below, which is the safest way to dispose off Na metal?
(a) Add small amount of Na to propan-2-ol
(b) Add small amount of Na to ethanol
(c) Add small amount of Na to propan-1-ol
(d) Add small amount of Na to water

33. Which one of the following is most stable?

(a) 

(b) 

(c) 

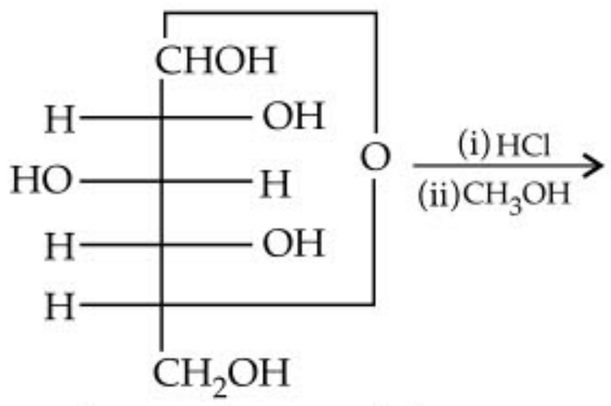
(d) 

34. Which of the following reactions, has the given relationship

$$\log\frac{K_p}{K_c} + \log RT = 0?$$

(a) $PCl_5 \rightleftharpoons PCl_3 + Cl_2$
(b) $2SO_2 + O_2 \rightleftharpoons 2SO_3$
(c) $H_2 + I_2 \rightleftharpoons 2HI$
(d) $N_2 + 3H_2 \rightleftharpoons 2NH_3$

35. Select the false statement about the following reaction :



(a) An oxonium cation participates.
(b) Only one —OH group becomes $-OCH_3$.
(c) The product is an acetal.
(d) The third —OH group from anomeric carbon becomes $-OCH_3$ group.

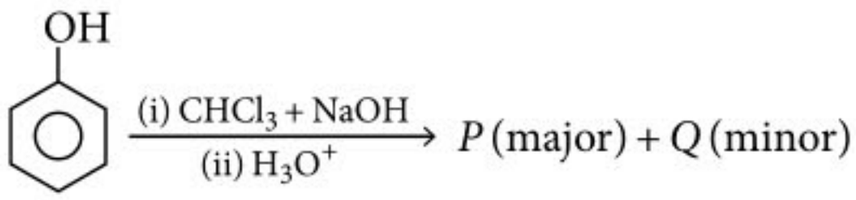
36. Which of the following cuprous compounds is not stable?
(a) Cu_2O (b) $Cu_2(CNS)_2$
(c) Cu_2Cl_2 (d) Cu_2SO_4

37. The total kinetic energy of a sample of gas which contains N molecules at −123 °C is E_k joules. Another sample of the same gas at 27 °C has total kinetic energy $2E_k$ joules. The number of molecules in the second sample of gas is
(a) $N/2$ (b) $2N$ (c) N (d) N^2

38. Arrange the following species according to their bond angle order :
(I) O_3 (II) NO_2^- (III) FNO
(a) I > II > III (b) II > I > III
(c) III > II > I (d) II > III > I

39. Which of the following options is correctly characterised by the given statements?
(i) It is formed when red phosphorus is heated in a sealed tube at 803 K.
(ii) It can be sublimed in air.
(iii) It has opaque monoclinic or rhombohedral crystals.
(a) White P (b) Yellow P
(c) α-Black P (d) β-Black P

40. Consider the reaction,



Mixture of P and Q can be best separated by
(a) steam distillation (b) vacuum distillation
(c) fractional distillation (d) crystallisation.

ASSERTION AND REASON

Directions : In the following questions (41-60), a statement of assertion is followed by a statement of reason. Mark the correct choice as :
(a) If both assertion and reason are true and reason is the correct explanation of assertion.
(b) If both assertion and reason are true but reason is not the correct explanation of assertion.
(c) If assertion is true but reason is false.
(d) If both assertion and reason are false.

41. **Assertion :** The pK_a of a weak acid becomes equal to pH of the solution at the midpoint of its titration.
Reason : The molar concentrations of proton acceptor and proton donor become equal at the midpoint of titration of a weak acid.

42. **Assertion :** More electropositive element has greater electron donating effect.
Reason : Me_3SiCH_2COOH is more acidic than Me_3CCH_2COOH.

43. **Assertion :** Increase in surface area, increases rate of evaporation.
Reason : Stronger the intermolecular attractive forces, faster is the rate of evaporation at a given temperature.

44. **Assertion :** α-Hydrogen atoms in aldehydes and ketones are acidic.
Reason : The anion left after the removal of α-hydrogen is stabilized by inductive effect.

45. **Assertion :** The density of the substance decreases in Schottky defect.
Reason : AgBr shows both Frenkel as well as Schottky defects.

46. **Assertion :** The H-atom in CHF_3 can more easily undergo deuterium exchange on treatment with D_2O in alkaline solution than $CHCl_3$.
Reason : CHF_3 is more acidic than $CHCl_3$.

47. **Assertion :** Alkyl cyanide can be prepared by carbylamine reaction.
Reason : Ethylamine when heated with chloroform in presence of alcoholic KOH, ethyl cyanide is formed.

48. **Assertion :** CO_2 gas will have higher rate of liquifaction than H_2 gas.
Reason : CO_2 will have lower intermolecular forces of attraction than H_2.

49. **Assertion :** If the potential difference applied to an electron is made 4 times, the de Broglie wavelength associated is halved. (Initial kinetic energy of the electron was zero).

Reason : On making potential difference 4 times, velocity is doubled and hence according to de Broglie hypothesis λ is halved.

50. **Assertion :** Cyclopentadienyl anion is much more stable than allyl anion.
Reason : Cyclopentadienyl anion is aromatic in character.

51. **Assertion :** Sedatives are given to patients who are mentally agitated and violent.
Reason : Sedatives are used to suppress the activities of central nervous system.

52. **Assertion :** I_2 can displace Cl_2 from $NaClO_3$.
Reason : I is more electronegative than Cl.

53. **Assertion :** Only principal quantum number determines the energy of an electron in an orbital of Na atom.
Reason : For one electron system, the expression of energy is quite different from that obtained in Bohr's theory.

54. **Assertion :** There is no change in enthalpy of an ideal gas during compression at constant temperature.
Reason : Enthalpy of an ideal gas is a function of temperature and pressure.

55. **Assertion :** During the electrolysis of water, two faraday of charge will produce a total of 33.6 litre of gases at S.T.P. at electrodes.
Reason : Two faraday of charge will produce half mole of H_2 and one fourth mole of O_2 gas.

56. **Assertion :** CrO_3 reacts with HCl to form chromyl chloride gas.
Reason : Chromyl chloride has tetrahedral shape.

57. **Assertion :** A non-volatile solute is mixed in a solution then elevation of boiling point and depression of freezing point both are equal.
Reason : Elevation of boiling point and depression of freezing point both depend on melting point of non-volatile solute.

58. **Assertion :** Complexes containing three bidentate ligands show optical activity.
Reason : Octahedral complex $[Co(NH_3)_4Cl_2]Cl$ shows geometrical isomerism.

59. **Assertion :** Levigation is used for the separation of oxide ores from impurities.
Reason : Ore particles are removed by washing in a current of water.

60. **Assertion :** Classical smog is oxidising smog whereas photochemical smog is reducing smog.
Reason : Classical smog occurs in warm, dry and sunny climate whereas photochemical smog occurs in cool humid climate.

SOLUTIONS

1. (d) : In case of (a) and (b), there is partial double bond character in C—Cl bond and C-atom is sp^2-hybridised *i.e.*, C—Cl bond is stronger and hence, chlorine cannot be easily replaced.

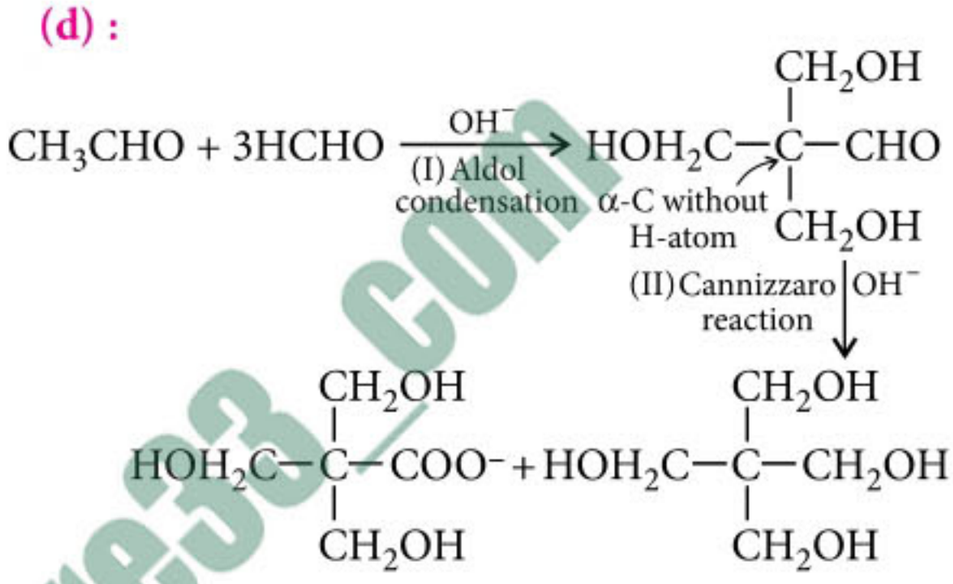
2. (c)

3. (c) : $\Lambda^\infty_{AcOH} = \Lambda^\infty_{NaOAc} + \Lambda^\infty_{HCl} - \Lambda^\infty_{NaCl}$

$= (91.0 + 426.2 - 126.5)\ S\ cm^2\ mol^{-1}$

$= 390.7\ S\ cm^2\ mol^{-1}$

4. (d) :



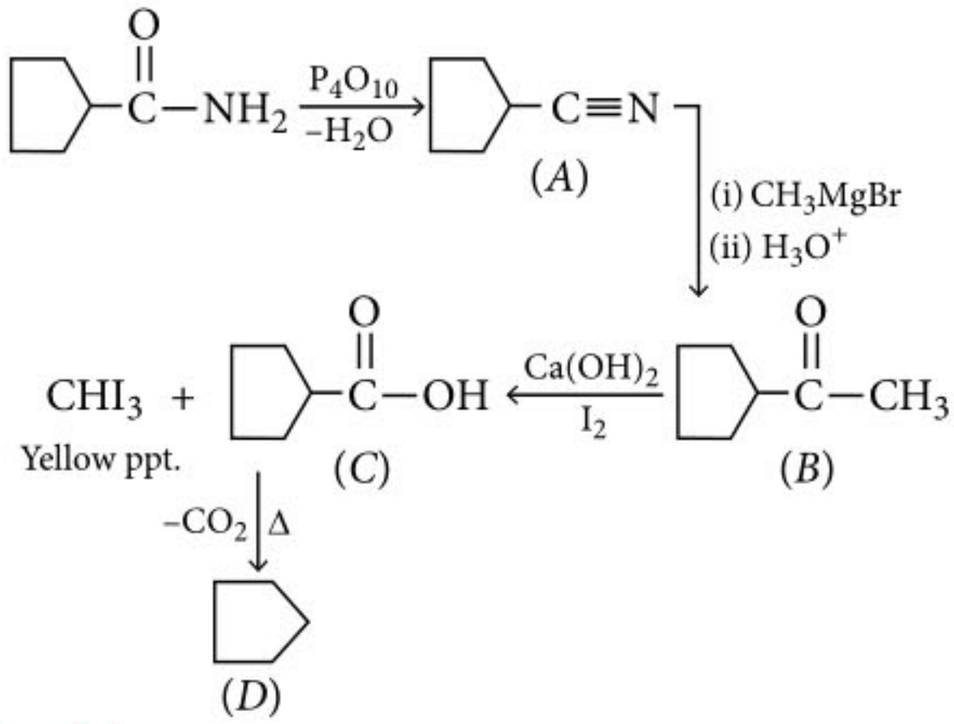
5. (c)

6. (b) : Rate $(r_1) = kC_A^2C_B^{1/2}$

If C_A is doubled and C_B increased four times

then, rate $= k(2C_A)^2(4C_B)^{1/2} = 4 \times 2\ kC_A^2C_B^{1/2} = 8\ r_1$.

7. (d) :



8. (c)

9. (b) : $E_{cell} = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{[Zn^{2+}]}{[Cu^{2+}]}$

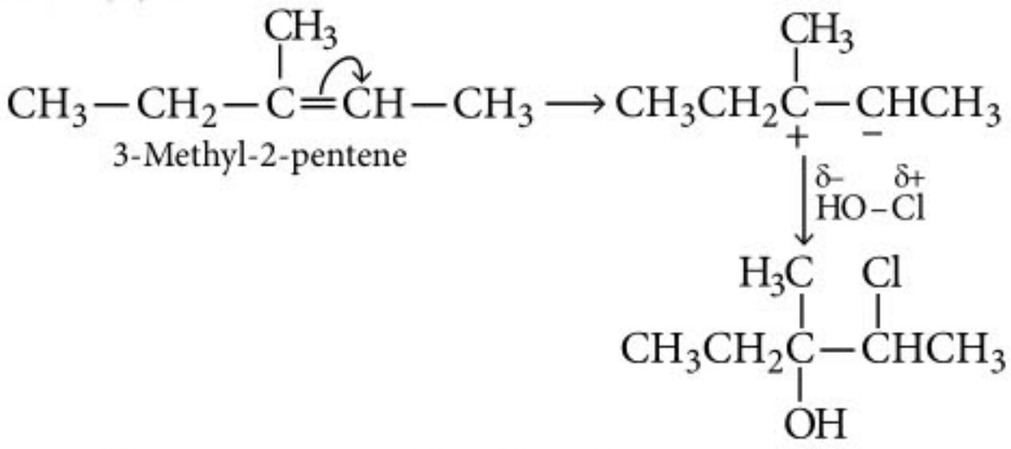
$E_1 = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{0.01}{1.0} = E^\circ_{cell} + 0.0591$

$E_2 = E^\circ_{cell} - \frac{0.0591}{2}\log\frac{1.0}{0.01} = E^\circ_{cell} - 0.0591$

$E_1 - E_2 = E^\circ_{cell} + 0.0591 - (E^\circ_{cell} - 0.0591) = 0.0591 \times 2$

10. (c) **11.** (d) **12.** (b) **13.** (a)

14. (d) :



15. (b) : Rate $\propto [R\text{Cl}] = k[R\text{Cl}]$

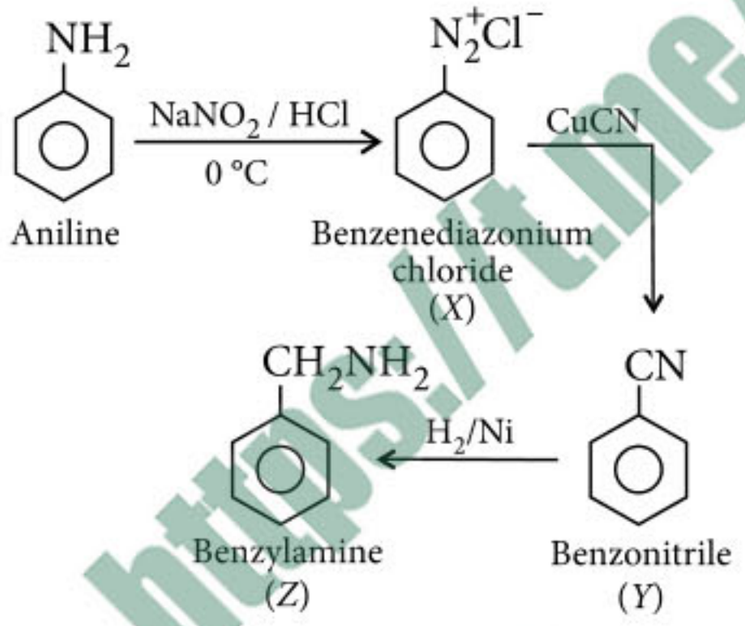
i.e., rate is of first order with respect to *R*Cl.

On reducing the [*R*Cl] to one half, rate will also be halved.

16. (a) : Phenol or it's derivates give tribromoderivatives on reaction with bromine water. Since, the compound on treatment with Br_2-water gives a tribromoderivative, therefore, it must be *m*-cresol, because it has two *ortho* and one *para* position free with respect to —OH group and hence can gives tribromoderivative.

17 (c) : KNO_3 is 100% ionized while CH_3COOH is a weak electrolyte and can not be completely ionized. Therefore, its osmotic pressure is lower than that of KNO_3.

18. (b) :

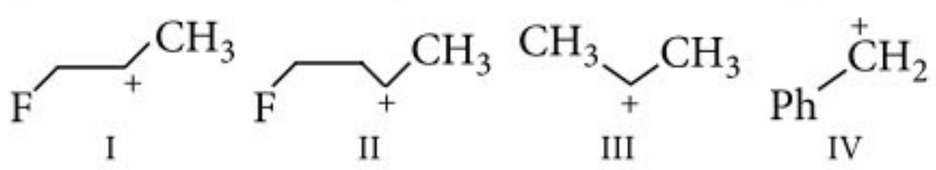


19. (b) **20.** (d) **21.** (b)

22 (c) : $\underset{(P)}{6Li + N_2} \xrightarrow{\Delta} \underset{(Q)}{2Li_3N} \xrightarrow{H_2O} \underset{(R)}{6LiOH} + \underset{(S)}{2NH_3}$

Further, LiOH(*R*) and NH_3(*S*) both react with HCl but only NH_3 gives white fumes of NH_4Cl.

23. (c) : The reactivity of alcohols towards conc. HCl depends on the stability of carbocation being formed.



Thus, the order of stability of these carbocations is IV > III > II > I. Hence, the order of reactivity will also be same.

24. (d)

25 (b) : Energy of electron in the n^{th} orbit of H-atom is, $E_n = -\dfrac{13.6}{n^2}$ eV

$\therefore\ E_1 = -13.6$ eV (as $n = 1$)

After absorbing 12.1 eV, the energy will be

$= -13.6$ eV + 12.1 eV $= -1.5$ eV

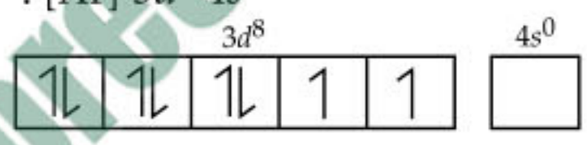
Thus, $-\dfrac{13.6}{n^2} = -1.5\text{ eV} \Rightarrow n^2 = 9$ or $n = 3$

Thus, electron will jump to III orbit.

26. (c) : Electronic configuration of

Ni : [Ar] $3d^8\ 4s^2$

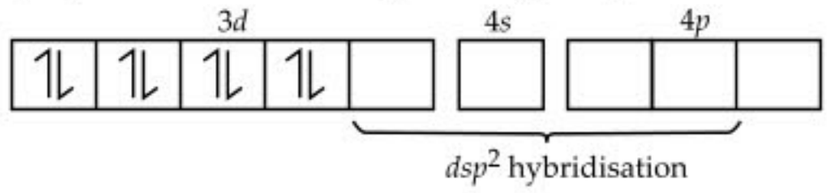
Ni^{2+} : [Ar] $3d^8\ 4s^0$



Paramagnetic behaviour is possible when pairing does not take place *i.e.*, 3*d* will not participate in bonding and hybridisation will be sp^3 including 4*s* and 4*p*, thus the structure is tetrahedral.

Diamagnetic behaviour is possible when pairing takes place (in presence of strong field ligand),

Ni^{2+} :



dsp^2 hybrid orbitals arrange in square planar structure.

27. (a) **28.** (c) **29.** (c)

30. (c) : $V_{initial} = 5$ L

$T = 27\ °C = 27 + 273 = 300$ K

$$V_{final} = \frac{nRT}{P} = \frac{10 \times 0.082 \times 300}{1} = 246\text{ L}$$

$\Delta V = V_{final} - V_{initial} = 246 - 5 = 241$ L

$W = -P\Delta V = -1 \times 241$ L-atm $= -241$ L-atm

31. (b) : Observed colligative property = $i \times$ Normal colligative property

(a) Elevation of b.pt. follows the order : $Y < X < Z$

$\Rightarrow$ b.pt. follows the order : $Y < X < Z$

(b) Depression of freezing point follows the order : $Y < X < Z$

$\Rightarrow$ Freezing point follows the order : $Z < X < Y$

$(T_f = T_f^{\circ} - \Delta T_f)$

(c) Osmotic pressure follows the order : $Y < X < Z$

(d) Relative lowering of the vapour pressure follows : $Y < X < Z$

Vapour pressure follows the order : $Z < X < Y$

32. (a) **33. (b)**

34. (b) : Using $K_p = K_c(RT)^{\Delta n_g}$

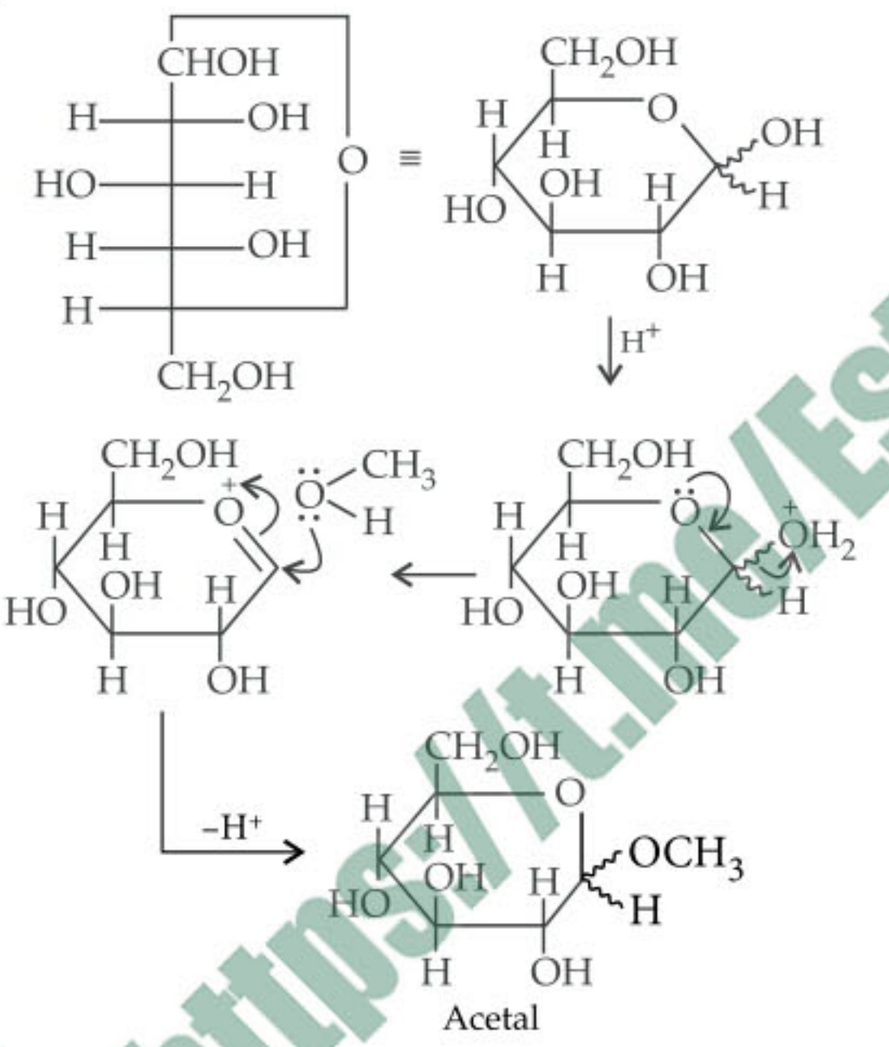
So, $\log \frac{K_p}{K_c} = \Delta n_g \log RT$

If $\Delta n_g = -1$, then relationship becomes

$$\log \frac{K_p}{K_c} + \log RT = 0$$

The reaction which shows $\Delta n_g = -1$ is in option (b).

35. (d) :



Acetal

36. (d)

37. (c) : $E_k = \frac{3}{2}\frac{R}{N} \times 150 = 225\frac{R}{N}$

$$2E_k = \frac{3}{2}\frac{R}{N_x} \times 300 = 450\,\frac{R}{N_x}$$

$\therefore\ 2 \times 225\frac{R}{N} = 450\frac{R}{N_x}$ or $N_x = N$

38. (a) **39. (c)** **40. (c)** **41. (a)**

42. (c) : Silicon is electropositive as compared to carbon and therefore has a larger electron donating $(+I)$-effect. This increases the electron density on oxygen atoms of carboxylate group. Hence, $Me_3SiCH_2COO^-$ is a stronger base than $Me_3CCH_2COO^-$. This means that Me_3CCH_2COOH is more acidic.

43. (c)

44. (c) : The anion left after the removal of α-hydrogen is stabilized by resonance effect.

45. (b)

46. (d) : $CHCl_3$ is more acidic than CHF_3 hence its H-atom can easily undergoes deuterium exchange on treatment with D_2O in alkaline solution.

47. (d) : When primary amines are heated with chloroform in the presence of alcoholic KOH, isocyanides are formed. This reaction is known as carbylamine reaction. *e.g.*, ethylamine gives ethyl isocyanide on treatment with $CHCl_3$ and alcoholic KOH.

$$C_2H_5NH_2 + CHCl_3 + 3KOH_{(alc.)} \xrightarrow{\Delta}$$

$$C_2H_5N \rightleftharpoons C + 3KCl + 3H_2O$$

48. (c) : Liquefaction $\propto$ intermolecular forces of attraction. Increasing order of liquefaction of some gases : $He < H_2 < O_2 < N_2 < CO_2$

49. (a) **50. (a)** **51. (a)**

52. (c) : $\overset{0}{I_2} + 2\overset{+5}{NaClO_3} \longrightarrow \overset{+5}{2NaIO_3} + \overset{0}{Cl_2}$

Cl is more electronegative than I.

53. (d) : For multielectron system, the expression of energy is quite different from that obtained in Bohr's theory. Thus, for sodium only principal quantum number is not enough to determine the energy.

54. (c) : The enthalpy of ideal gases and incompressible solids and liquids does not depend on pressure.

55. (c) : 2 faraday charge will release 22.4 litre H_2 and 11.2 litre O_2 at S.T.P. during the electrolysis of water.

$V(H_2) = 11.2$ L at S.T.P.

$V(O_2) = 5.6$ L at S.T.P.

Total volume liberated by 2 faraday charge

$= 2 \times 11.2 + 2 \times 5.6 = 33.6$ L at S.T.P.

56. (b)

57. (d) : Elevation of boiling point and depression of freezing point are colligative properties *i.e.*, they depend only on the number of particles of the solute. Value of K_b and K_f are different, so ΔT_b and ΔT_f are also different.

58. (b) **59. (c)** **60. (d)**

WHY CUTTING CBSE SYLLABUS ISN'T THE BEST FIX FOR STUDENT STRESS

Curriculum needs regular revision along with better teaching, evaluation system that takes away paranoia of exams

The human resource development ministry's proposal to cut the Central Board of Secondary Education (CBSE) syllabus by half has left educationists divided. One school of experts has welcomed it, while another says students' knowledge will take a hit.

Rather than announcing a new national curriculum framework to update the syllabus (the last revision was in 2005) — the ministry has said it would cut 50% of the syllabus. While the aim of the cut — to make time for sports and other skills and allow students a choice of subjects — is good, experts wonder whether this is the best way to achieve it.

"Syllabus review should be based on policies and academic reports not done arbitrarily," said Professor Janaki Rajan, department of teacher training, Jamia Millia Islamia. "We are told that it's a knowledge economy now, so it's baffling that the government wants to halve the syllabus."

Others believe 40% of the syllabus is obsolete and should be trimmed. "The syllabus was last reviewed in 2005 and we are still teaching that. Knowledge doubles every three to four years, and 40% of our content is obsolete," said Ashok Ganguly, former CBSE chairman and director of SCERT Uttar Pradesh.

An overall change in teaching methods is required. "First-generation learners cannot be graded alongside those who have the privilege of educated parents. The answer is not to reduce standards for all, but to have basic and advanced levels for subjects," said Anuradha Joshi, principal, Sardar Patel Vidyalaya, New Delhi. For example, she says, there could be two streams for mathematics; while the entire class does general mathematics, those with interest or ability can opt for an advanced paper. "It is the teaching system that needs to be changed and a reduction in syllabus alone won't help," said Joshi.

The Delhi government earlier said it would drop 25% of the syllabus, a move, educationists say was not thought through. "The AAP government proclaimed a 25% cut without any academic basis. Their cuts showed a lack of understanding of the purpose of education and the knowledge that is required," said Rajan. She gave the example of the proposal to do away with lessons on the Constitution for Class 8 as it was taught in Class 12. "But only children in social science streams study the Constitution in Class 12. Science and commerce students would grow up without vital knowledge," she said.

While advocating for updation of the syllabus, eminent educationist and former member of the RTE council Mrinal Miri said, "A syllabus review requires critical reflection."

Schools would like National Council Of Educational Research and Training (NCERT) to compare physics, chemistry, biology and economics lessons for Classes 11 and 12 with what is taught in the first year of college. "A lot of the material is repeated," said Joshi. "Rather than reducing the syllabus, the language of teaching should be made child-friendly. If a child can understand in the early years, he/she develops an essential skill set," she said.

Avnita Bir, director and principal, RN Podar School, Mumbai, said, "A review is required but it can't be done mindlessly." She said teachers and school heads from across the country had to be consulted. "When everyone contributes to the change, there is a better sense of ownership and it will help the government understand ground realities," said Bir.

WHAT EXPERTS SUGGEST | CHANGES NEEDED TO...

SYLLABUS

► Update syllabus to reflect latest advances in science, history, maths.

► Compare curriculum across school and college levels to eliminate repetition of topics.

PEDAGOGY

► Split subjects into basic and advanced papers so that students can choose how deeply they go into a subject.

► Language of teaching should be child-friendly.

ASSESSMENT

► A return to continuous and comprehensive evaluation that assesses a student's all-round development throughout the year.

BOARD EXAMS

► The word 'board' adds tension to an exam without improving learning outcomes. Removing board exams from class 10 was a good step, go back to it.

Courtesy : The Times of India

CHEMISTRY MUSING

SOLUTION SET 56

1. (a) : Acidic buffer (NaCN + HCN),

$$pH = pK_a + \log\left[\frac{\text{Salt}}{\text{Acid}}\right]$$

Pt $|H_2|$ Buffer (NaCN+HCN) | Buffer (NaCN + HCN) $|H_2|$ Pt

$$pH_1 = pK_a + \log\frac{x}{y},\quad pH_2 = pK_a + \log\frac{y}{x}$$

$E_1 = a = -0.059\ pH_1$, $E_2 = b = -0.059\ pH_2$

$a - b = -0.059\ pH_1 + 0.059\ pH_2 = 0.059\ (pH_2 - pH_1)$

$$35.52 \times 10^{-3}\ V = 0.059\left(pK_a + \log\frac{y}{x} - pK_a - \log\frac{x}{y}\right)$$

$$\text{or, } \frac{35.52\times10^{-3}}{0.059} = \log\frac{y}{x} + \log\frac{y}{x}$$

$$0.6 = 2\log\frac{y}{x},\ \log\frac{y}{x} = 0.3 \Rightarrow \frac{y}{x} = 2$$

2. (c) : Celestine is $SrSO_4$, thus Z is strontium. So, Y is Rb, X is Kr and W is Br. Hence, most stable compound is W_2Z.

3. (c) : Evolution of N_2 with HNO_2 suggests that the amine is primary.

59.07 g of I is present in 100 g of the compound.

127 g of I (1 mol) is present in $\frac{100\times127}{59.07}$

= 215 g of the compound

$\therefore$ Molecular mass of the compound = 215

$$CH_3NH_2 \xrightarrow{3CH_3I} \left[CH_3 - \overset{+}{N}(CH_3)_3\right]I^-$$

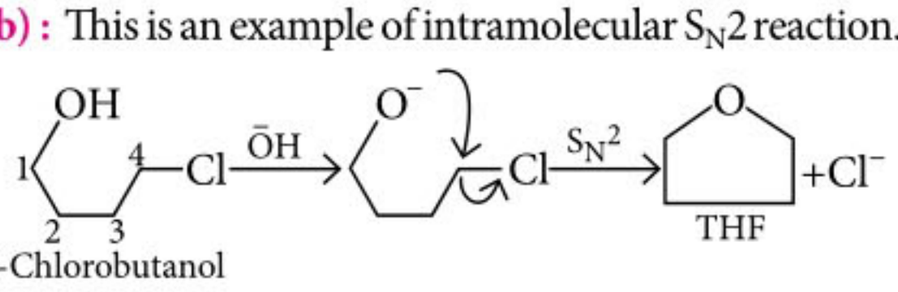
(Molecular mass = 201)

$$C_2H_5NH_2 \xrightarrow{3CH_3I} \left[C_2H_5 - \overset{+}{N}(CH_3)_3\right]I^-$$

(Molecular mass = 215)

Hence, the amine is $C_2H_5NH_2$.

4. (b) : This is an example of intramolecular S_N2 reaction.



4-Chlorobutanol

5. (a) : HCl, HNO_3 and H_2SO_4 form azeotropes at 20%, 68% and 98% respectively by mass of acid.

Therefore, for HCl = 20/100 = 1/5

For HNO_3 = 68/100 ≈ 2/3

For H_2SO_4 = 98/100 ≈ 3/3

Thus, ordinary strong solutions of HCl, HNO_3 and H_2SO_4 contain roughly 1/5, 2/3 and 3/3 fractions of pure acid in water respectively.

6. (c) : Given, $\frac{k_{293\,K}}{k_{276\,K}} = 3$; $T_2 = 293$ K and $T_1 = 276$ K

$$2.303\log_{10}\frac{k_2}{k_1} = \frac{E_a}{R}\left(\frac{T_2 - T_1}{T_1T_2}\right)$$

$$\therefore\quad 2.303\log_{10}3 = \frac{E_a}{2}\left(\frac{293-276}{293\times276}\right)$$

$\therefore\quad E_a = 10453.95$ cal = 10.454 kcal

Also, $2.303\log_{10}\frac{k_3}{k_2} = \frac{E_a}{R}\left(\frac{T_3 - T_2}{T_3T_2}\right)$

This time, E_a = 10.454 kcal; T_3 = 313 K and T_2 = 293 K

$$\therefore\quad 2.303\log_{10}\frac{k_3}{k_2} = \frac{10.454\times10^3}{2}\left(\frac{313-293}{313\times293}\right)$$

$$\therefore\quad \frac{k_3}{k_2} = 3.12$$

MHRD is inviting suggestions on rationalising curriculum / syllabus / subject contents for class I to class XII with the objective of all round development of students

It has been envisioned that in order to develop a fairer and more egalitarian society comprising of well-balanced human beings, in addition to cognitive and analytical skills ,adequate attention on activities like life skills, experiential learning, health and physical education, sports, visual and performing arts, literary & creative skills, and work based education are indispensable. Though the existing curriculum does incorporate these skills, however, the load of curriculum in cognitive and analytical area seems to be so heavy that students practically do not get much time to develop skills in other areas.

In order to balance the curriculum for cognitive and analytical areas with curriculum in other life skills including creativity and sports, specific suggestions are invited from teachers, academics, students, parents and other stakeholders associated with school education. The objective is to make the content more balanced in various subjects offered from class I to class XII as prescribed by NCERT/CBSE. Suggestions could be made latest by 6th April (Friday) 2018. For more details visit CBSE/MHRD websites.

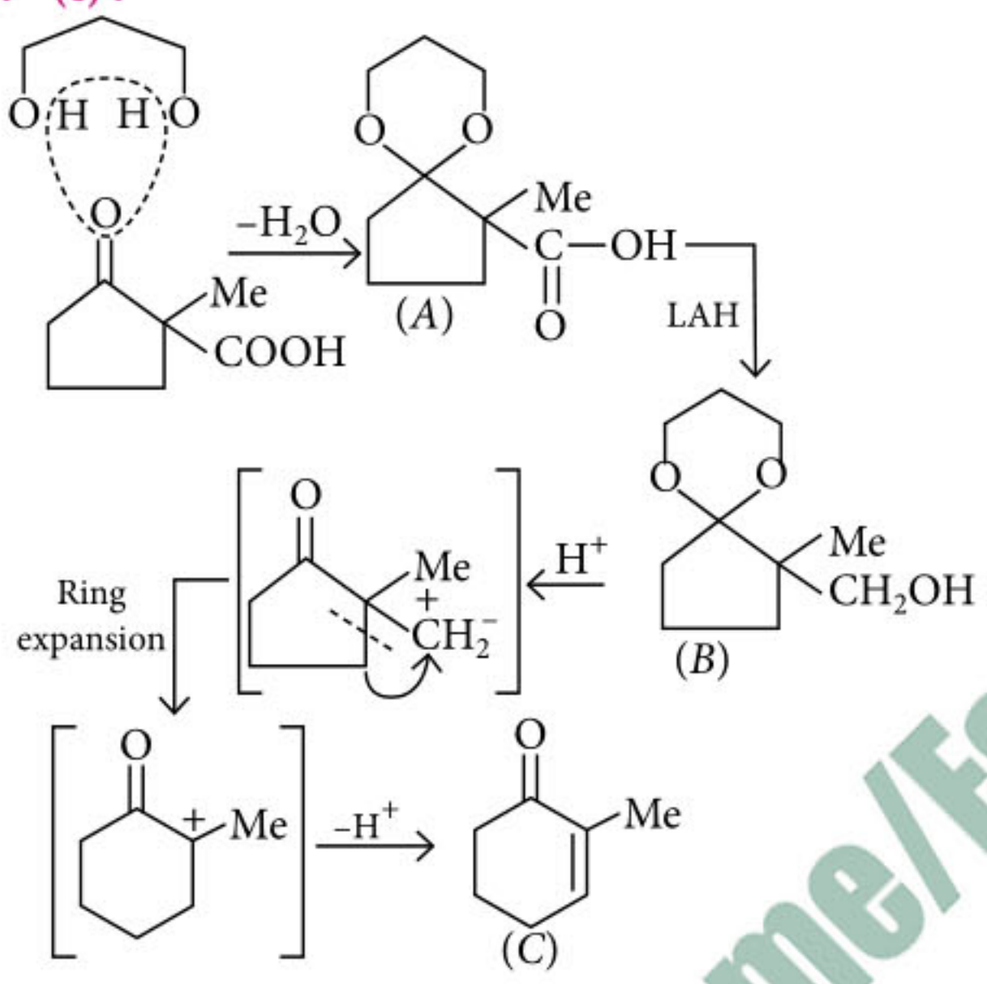
Now, $\frac{k_3}{k_2}=\frac{t_2}{t_3}$ $\because k \propto \frac{1}{\text{time}}$

Also if milk is not soured upto 64 hr at 20 °C, it will not sour upto 192 hr at 3 °C. Similarly, we can have

$$t_3 = t_2 \times \frac{k_2}{k_3} = 64 \times \frac{1}{3.12} = 20.5 \text{ hr}$$

7. (d): All of the given reagents are used in haloform reactions, which followed by hydrolysis convert MeCO— to —COOH group.

8. (c) :



9. (8): NO, NO_2, O_2, $K_3[Fe(CN)_6]$, KO_2, $MnSO_4$, $NiSO_4$, $CuSO_4$ are paramagnetic and their apparent weights increase by applying magnetic field.

10. (5): Let x mol of O_2 is liberated and $3x$ mol of $H_2S_2O_8$ is formed.

Reaction at cathode (reduction) :

$2H_2O + 2e^- \rightarrow H_2 + 2OH^-$

Reactions at anode (oxidation) :

(i) $2H_2O \rightarrow O_2 + 4H^+ + 4e^-$ $\left[\begin{array}{c} 1 \text{ mol } O_2 \equiv 4F \\ x \text{ mol } O_2 = 4x \text{ F} \end{array}\right]$

(ii) $2SO_4^{2-} \rightarrow S_2O_8^{2-} + 2e^-$ $\left[\begin{array}{c} 1 \text{ mol } S_2O_8^{2-} \equiv 2F \\ 3x \text{ mol } S_2O_8^{2-} = 6x \text{ F} \end{array}\right]$

Total faradays at anode = $(4x + 6x)$ F = $10x$ F.

Total faradays at cathode = $2F \equiv 1$ mol H_2

$10x$ F ≡ Total faradays at cathode

= Total Faradays at anode

2F at cathode ≡ 1 mol of H_2.

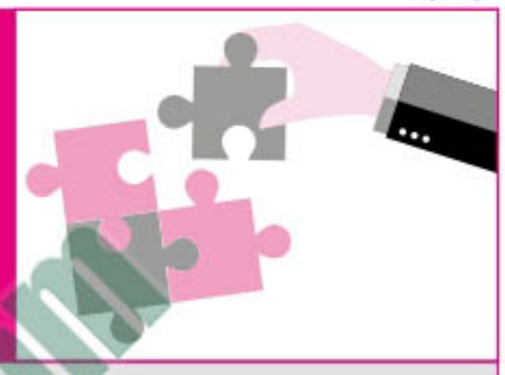
$\therefore$ $10x$ F at cathode $\equiv \frac{1}{2F} \times 10x \text{ F} = 5x$ mol of H_2.

$$\text{Ratio} = \frac{\text{Moles of } H_2 \text{ at cathode}}{\text{Moles of } H_2S_2O_8 \text{ at anode}} = \frac{5x}{3x} = \frac{5}{3}$$

Thus, $a : b$ is 5 : 3.

Thus, $3 \times \frac{a}{b} = 3 \times \frac{5}{3} = 5$

PUZZLE CORNER



CHEMDOKU

Introducing chemdoku, a mixture of ken-ken, sudoku and chemistry.

In this puzzle 5 × 5 grid is given, your objective is to fill the digits 1-5 so that each appear exactly once in each row and each column.

Notice that most boxes are part of a cluster. In the upper-left corner of each multibox cluster is a value that is multiple of its numbers. For example, if that value is 3 for a two-box cluster, you know that only 1 and 3 can go in there. But it is your job to determine which number goes where! A few cluster may have just one box and that is the number that fills that box.

Note : Atomic number of the given elements to be considered as your answer.

Clues :

	a		b	
c		d		
e				
		f		
g		h		

(a) It forms in the belly of stars in a reaction called the triple alpha process.

(b) The metal is hard, silver white in colour, very resistant to oxidation although it dissolves in non-oxidizing acids. Widely used in electroplating, as an additive for steel.

(c) I am a God, a planet and I can measure heat. Who am I?

(d) Obtained by fractional distillation of liquid air. Widely used in fluorescent tubes, lighting and Geiger-Muller tubes.

(e) Besides oxygen and carbon, a key element in the spiral "backbone" of DNA.

(f) A toxic silvery metal, belongs to lanthanoid series. It occurs in mineral monazite. It is used to produce special dark glasses.

(g) The second most common element in stars.

(h) The first man made nuclear reaction took place in 1932 when this metal was converted to helium through transmutation.

Readers can send their responses at editor@mtg.in or post us with complete address by 25th of every month to win exciting prizes. Winners' name with their valuable feedback will be published in next issue.

Are you Anxious about your Exams?

5 TIPS to overcome it

01 Plan your strategies

It is worth spending some time, first in planning what needs to be done rather than simply sitting down to work, which leads to more stress. Plan out well in advance, keeping in mind your goals and implement strategies accordingly.

02 Prioritize your tasks

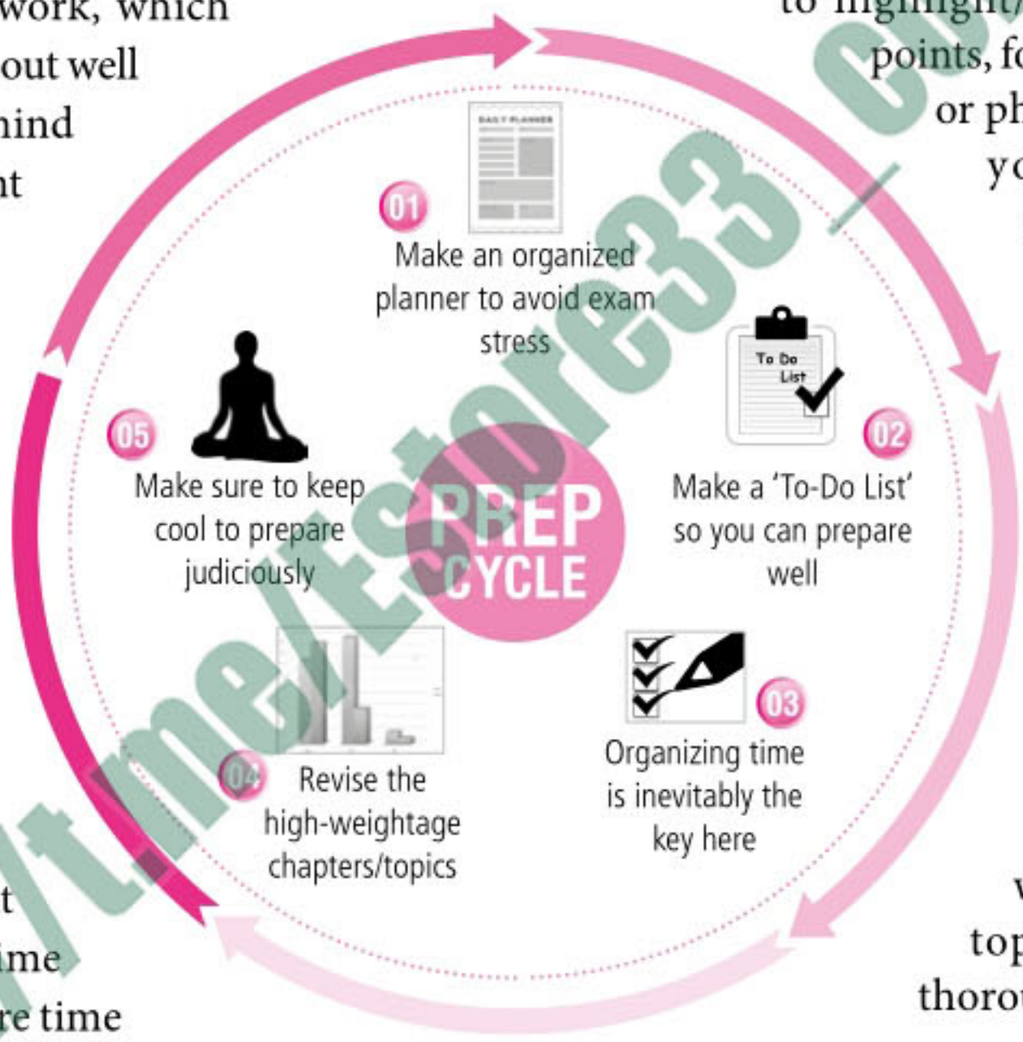
While making a timetable, prioritize topics which are more important/ scoring than others. Make a realistic timetable, ensuring that you are giving enough time to each subject. Allot more time to practice concepts and chapters that you find difficult. Make sure you revise the topics time to time.

03 Manage your time well

Manage your time effectively to ensure that you get time not just to study but for your routine activities as well. Attempt mock test papers as many as you can to gauge your speed, accuracy and knowledge and this will also help in time management during exam.

04 Use time-saving tactics

As most of the times, the same topic needs to be revised more than once thus, make it a habit to highlight/underline important points, formulae, specific words or phrases, that would help you save time when you revise the same topic again. Solved previous years' question bank is a million dollar gift to any student preparing for the exams. Check out the blueprint of previous years' question papers and try to locate high weightage chapters/ topics and revise these thoroughly.



05 Take a break, stay healthy and meditate

There is no harm in relaxing and taking a break from studies. Physical activity keeps the mind healthy and active, which ultimately improves concentration and memorising power. Eating healthy and keeping yourself hydrated is crucial as the pressure, stress and long study hours can take a toll on one's health. Meditating will help you in recollecting all that you have studied and improvise your memory. Sleep well a night before the exam.

CBSE BOARD SOLVED PAPER 2018

Time Allowed : 3 hours
Maximum Marks : 70

GENERAL INSTRUCTIONS

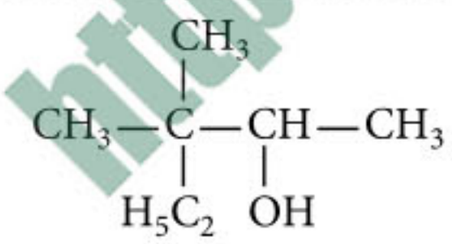
(i) All questions are compulsory.
(ii) Questions number 1 to 5 are very short answer questions and carry 1 mark each.
(iii) Questions number 6 to 10 are short answer questions and carry 2 marks each.
(iv) Questions number 11 to 22 are also short answer questions and carry 3 marks each.
(v) Question number 23 is a value based question and carries 4 marks.
(v) Questions number 24 to 26 are long answer questions and carry 5 marks each.
(vi) Use log tables, if necessary. Use of calculators is not allowed.

1. Write the coordination number and oxidation state of platinum in the complex $[Pt(en)_2Cl_2]$.

2. Analysis shows that FeO has a non-stoichiometric composition with formula $Fe_{0.95}O$. Give reason.

3. Out of chlorobenzene and benzyl chloride, which one gets easily hydrolysed by aqueous NaOH and why?

4. Write the IUPAC name of the following :



5. $CO_{(g)}$ and $H_{2(g)}$ react to give different products in the presence of different catalysts. Which ability of the catalyst is shown by these reactions?

6. Among the hydrides of group-15 elements, which have the
(a) lowest boiling point
(b) maximum basic character
(c) highest bond angle
(d) maximum reducing character?

7. Calculate the freezing point of a solution containing 60 g of glucose (molar mass = 180 g mol^{-1}) in 250 g of water. (K_f of water = 1.86 K kg mol^{-1})

8. How do you convert the following :
(a) Ethanal to propanone
(b) Toluene to benzoic acid?

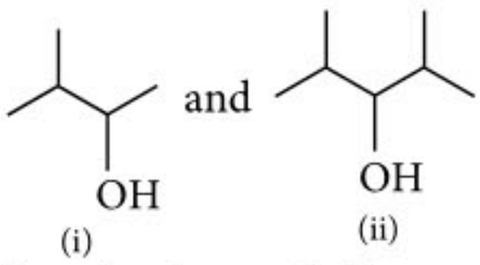
OR

Account for the following :
(a) Aromatic carboxylic acids do not undergo Friedel–Crafts reaction.
(b) pK_a value of 4-nitrobenzoic acid is lower than that of benzoic acid.

9. Complete and balance the following chemical equations :
(a) $Fe^{2+} + MnO_4^- + H^+ \longrightarrow$
(b) $MnO_4^- + H_2O + I^- \longrightarrow$

10. For the reaction, $2N_2O_{5(g)} \longrightarrow 4NO_{2(g)} + O_{2(g)}$, the rate of formation of $NO_{2(g)}$ is 2.8×10^{-3} M s^{-1}. Calculate the rate of disappearance of $N_2O_{5(g)}$.

11. **(a)** Identify the chiral molecule in the following pair :



(i) (ii)

(b) Write the structure of the product when chlorobenzene is treated with methyl chloride in the presence of sodium metal and dry ether.

(c) Write the structure of the alkene formed by dehydrohalogenation of 1-bromo-1-methylcyclohexane with alcoholic KOH.

12. A first order reaction is 50% completed in 40 minutes at 300 K and in 20 minutes at 320 K. Calculate the activation energy of the reaction. (Given : log 2 = 0.3010, log 4 = 0.6021, $R = 8.314\ J\ K^{-1}\ mol^{-1}$)

13. An element '*X*' (At. mass = 40 g mol^{-1}) having *fcc* structure, has unit cell edge length of 400 pm. Calculate the density of '*X*' and the number of unit cells in 4 g of '*X*' ($N_A = 6.022 \times 10^{23}\ mol^{-1}$).

14. Give reasons for the following :

(a) Measurement of osmotic pressure method is preferred for the determination of molar masses of macromolecules such as proteins and polymers.

(b) Aquatic animals are more comfortable in cold water than in warm water.

(c) Elevation of boiling point of 1 M KCl solution is nearly double than that of 1 M sugar solution.

15. What happens when

(a) a freshly prepared precipitate of $Fe(OH)_3$ is shaken with a small amount of $FeCl_3$ solution

(b) persistent dialysis of a colloidal solution is carried out

(c) an emulsion is centrifuged?

16. Write the chemical reactions involved in the process of extraction of Gold. Explain the role of dilute NaCN and Zn in this process.

17. (*A*), (*B*) and (*C*) are three non-cyclic functional isomers of a carbonyl compound with molecular formula C_4H_8O. Isomers (*A*) and (*C*) give positive Tollens' test whereas isomer (*B*) does not give Tollens' test but gives positive iodoform test. Isomers (*A*) and (*B*) on reduction with Zn(Hg)/ conc. HCl give the same product (*D*).

(a) Write the structures of (*A*), (*B*), (*C*) and (*D*).

(b) Out of (*A*), (*B*) and (*C*) isomers, which one is least reactive towards addition of HCN?

18. **(a)** Why is bithional added to soap?

(b) What is tincture of iodine? Write its one use.

(c) Among the following, which one acts as a food preservative?

Aspartame, Aspirin, Sodium Benzoate, Paracetamol

19. **(a)** Write the formula of the following coordination compound :

Iron (III) hexacyanoferrate(II)

(b) What type of isomerism is exhibited by the complex $[Co(NH_3)_5Cl]SO_4$?

(c) Write the hybridisation and number of unpaired electrons in the complex $[CoF_6]^{3-}$. (Atomic no. of Co = 27)

20. Define the following with an example of each :

(a) Polysaccharides

(b) Denatured protein

(c) Essential amino acids

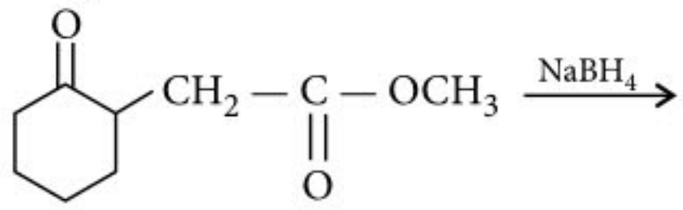
OR

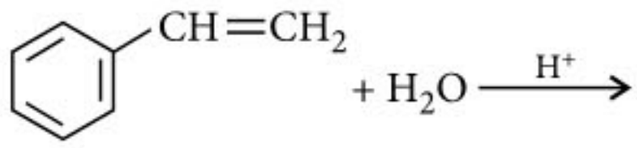
(a) Write the product when *D*-glucose reacts with conc. HNO_3.

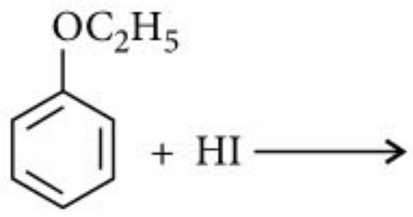
(b) Amino acids show amphoteric behaviour. Why?

(c) Write one difference between α-helix and β-pleated structures of proteins.

21. Write the structures of the main products in the following reactions :

(i) 

(ii) 

(iii) 

22. Give reasons :

(a) E° value for Mn^{3+}/Mn^{2+} couple is much more positive than that for Fe^{3+}/Fe^{2+}.

(b) Iron has higher enthalpy of atomization than that of copper.

(c) Sc^{3+} is colourless in aqueous solution whereas Ti^{3+} is coloured.

23. Shyam went to a grocery shop to purchase some food items. The shopkeeper packed all the items in polythene bags and gave them to Shyam. But Shyam

refused to accept the polythene bags and asked the shopkeeper to pack the items in paper bags. He informed the shopkeeper about the heavy penalty imposed by the government for using polythene bags. The shopkeeper promised that he would use paper bags in future in place of polythene bags.
Answer the following :

(a) Write the values (at least two) shown by Shyam.

(b) Write one structural difference between low density polythene and high density polythene.

(c) Why did Shyam refuse to accept the items in polythene bags?

(d) What is a biodegradable polymer? Give an example.

24. (a) Write the reactions involved in the following :

(i) Hofmann bromamide degradation reaction

(ii) Diazotisation

(iii) Gabriel phthalimide synthesis

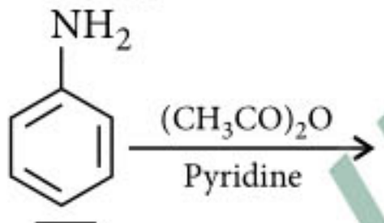
(b) Give reasons :

(i) $(CH_3)_2NH$ is more basic than $(CH_3)_3N$ in an aqueous solution.

(ii) Aromatic diazonium salts are more stable than aliphatic diazonium salts.

OR

(a) Write the structures of the main products of the following reactions :

(i) 

(ii) 

(iii) 

(b) Give a simple chemical test to distinguish between aniline and *N*, *N*-dimethylaniline.

(c) Arrange the following in the increasing of their pK_b values :
$C_6H_5NH_2$, $C_2H_5NH_2$, $C_6H_5NHCH_3$

25. (a) Give reasons :

(i) H_3PO_3 undergoes disproportionation reaction but H_3PO_4 does not.

(ii) When Cl_2 reacts with excess of F_2, ClF_3 is formed and not FCl_3.

(iii) Dioxygen is a gas while sulphur is a solid at room temperature.

(b) Draw the structures of the following :

(i) XeF_4 **(ii)** $HClO_3$

OR

(a) When concentrated sulphuric acid was added to an unknown salt present in a test tube a brown gas (*A*) was evolved. This gas intensified when copper turnings were added to this test tube. On cooling, the gas (*A*) changed into a colourless solid (*B*).

(i) Identify (*A*) and (*B*).

(ii) Write the structures of (*A*) and (*B*).

(iii) Why does gas (*A*) change to solid on cooling?

(b) Arrange the following in the decreasing order of their reducing character :
HF, HCl, HBr, HI

(c) Complete the following reaction :
$XeF_4 + SbF_5 \longrightarrow$

26. (a) Write the cell reaction and calculate the e.m.f. of the following cell at 298 K:
$Sn_{(s)} \mid Sn^{2+}$ (0.004 M) $\| H^+$ (0.020 M) $\mid H_{2(g)}$ (1 bar) $\mid Pt_{(s)}$
(Given : $E^\circ_{Sn^{2+}/Sn} = -0.14$ V)

(b) Give reasons :

(i) On the basis of E° values, O_2 gas should be liberated at anode but it is Cl_2 gas which is liberated in the electrolysis of aqueous NaCl.

(ii) Conductivity of CH_3COOH decreases on dilution.

OR

(a) For the reaction,
$2AgCl_{(s)} + H_{2(g)}$ (1 atm) $\rightarrow 2Ag_{(s)} + 2H^+$ (0.1 M) $+ 2Cl^-$(0.1 M)
$\Delta G^\circ = -43600$ J at 25 °C.
Calculate the e.m.f. of the cell. ($\log 10^{-n} = -n$)

(b) Define fuel cell and write its two advantages.

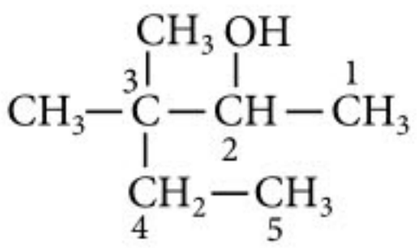
SOLUTIONS

1. Co-ordination number and oxidation state of Pt in the complex $[Pt(en)_2Cl_2]$ are 6 and +2 because *en* is a bidentate and neutral ligand.

2. In FeO crystal some of the Fe^{2+} ions are replaced by Fe^{3+} ions. Three Fe^{2+} ions are replaced by two Fe^{3+} ions to maintain electrical neutrality. Eventually there will be less amount of metal ($Fe_{0.95}O$)as compared to stoichiometric proportion (FeO).

3. Benzyl chloride gets easily hydrolysed by aq. NaOH due to formation of stable benzyl carbocation. But due to partial double bond character of C — Cl bond in chlorobenzene, it does not hydrolyse.

4.



3,3 – Dimethylpentan-2-ol

5. The selectivity of a catalyst is its ability to yield a particular product in the reaction *e.g.*,

$$CO + 3H_2 \xrightarrow{Ni} CH_4 + H_2O$$

$$CO + 2H_2 \xrightarrow{Cu/ZnO\text{-}Cr_2O_3} CH_3OH$$

6. **(a)** PH_3 (Phosphine)
(b) NH_3 (ammonia)
(c) NH_3 (ammonia)
(d) BiH_3 (Bismuth hydride)

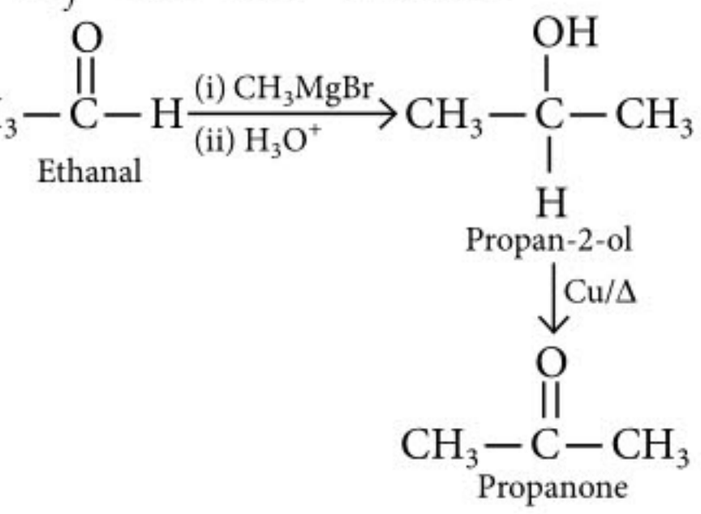
7. Mass of glucose ($C_6H_{12}O_6$), $W_2 = 60$ g
Mass of water, $W_1 = 250$ g
M_2 (Mol. mass of $C_6H_{12}O_6$) = 180 g mol^{-1}
$K_f = 1.86$ K kg mol^{-1}, T_f = ?

Using formula, $\Delta T_f = K_f \times \dfrac{W_2 \times 1000}{M_2 \times W_1}$

$$= 1.86 \times \frac{60 \times 1000}{180 \times 250} = 2.48 \text{ K}$$

$\Delta T_f = T_f^\circ - T_f$
or $T_f = T_f^\circ - \Delta T_f = 273 - 2.48 = 270.52$ K

8. **(a)**



(b) *Refer to answer 127 (iii), Page. no. 265 (MTG CBSE Champion Chemistry)*

OR

(a) Due to presence of electron withdrawing group (—COOH) in aromatic carboxylic acids, they do not undergo Friedel Crafts reaction.
(b) Due to presence of strong electron withdrawing group (—NO_2), 4-nitrobenzoic acid is more acidic than benzoic acid and therefore, pk_a value is lower.

9. **(a)** *Refer to answer 97 (i), Page no. 175 (MTG CBSE Champion Chemistry)*
(b) $2MnO_4^- + H_2O + I^- \rightarrow 2OH^- + 2MnO_2 + IO_3^-$

10. Given, $\dfrac{d[NO_2]}{dt} = 2.8 \times 10^{-3}$ M s^{-1}

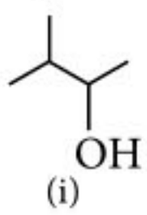
According to rate law expression,

$$-\frac{1}{2}\frac{d[N_2O_5]}{dt} = \frac{1}{4}\frac{d[NO_2]}{dt} = \frac{d[O_2]}{dt}$$

$$\therefore \quad -\frac{1}{2}\frac{d[N_2O_5]}{dt} = \frac{1}{4}\times 2.8\times 10^{-3}$$

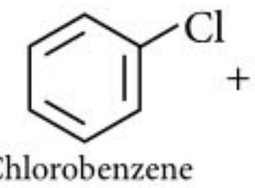
$$\frac{-d[N_2O_5]}{dt} = \frac{1}{2}\times 2.8\times 10^{-3} = 1.4\times 10^{-3}\ M\ s^{-1}$$

11. (a)



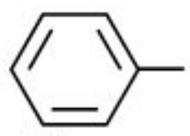
(i)

(b)



Chlorobenzene + 2Na + Cl — CH_3 (Methyl chloride)

Dry Ether →



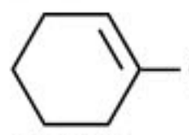
CH_3 + 2NaCl

Toluene

(c)

alc. KOH →

1-Bromo-1-methylcyclohexane



CH_3 +

$=CH_2$

(major) (minor)

12. $(t_{1/2})_1 = 40$ min, $(t_{1/2})_2 = 20$ min

$T_1 = 300$ K, $T_2 = 320$ K

$E_a = ?$

For 1st order reaction,

$$k_1 = \frac{0.693}{(t_{1/2})_1} = \frac{0.693}{40} = 0.017\ min^{-1}$$

$$k_2 = \frac{0.693}{(t_{1/2})_2} = \frac{0.693}{20} = 0.034\ min^{-1}$$

From Arrhenius equation,

$$\log\frac{k_2}{k_1} = \frac{E_a}{2.303\,R}\left[\frac{T_2 - T_1}{T_1T_2}\right]$$

$$\log\frac{0.034}{0.017} = \frac{E_a}{2.303\times 8.314}\left[\frac{20}{320\times 300}\right]$$

$$E_a = \frac{0.3010\times 2.303\times 8.314\times 320\times 300}{20}$$

$E_a = 27663.8\ J = 27.6\ kJ$

13. Given, $a = 400$ pm

For *fcc*, $Z = 4$

$$d = \frac{Z\times M}{N_A\times a^3} = \frac{4\times 40}{6.022\times 10^{23}\times(400\times 10^{-10})^3} = 4.15\ g\ cm^{-3}$$

$$\text{Mass of one unit cell} = \frac{4\times 40}{6.022\times 10^{23}}\ g$$

$$\text{No. of unit cells} = \frac{\text{Weight of cubic crystal}}{\text{Mass of unit cell}}$$

$$= \frac{6.022\times 10^{23}}{4\times 40}\times 4$$

$$= 1.505\times 10^{22}\ \text{unit cells}$$

14. (a) In osmotic pressure method, pressure measurement is around the room temperature and the molarity of the solution is used instead of molality. That is why this method is used for determination of molar masses of macromolecules as they are generally not stable at higher temperatures.

(b) *Refer to answer 18, Page no. 34 (MTG CBSE Champion Chemistry)*

(c) i for 1 M KCl = 2

i for 1 M sugar solution = 1

$\therefore \Delta T_b = iK_b\,m = 2\,K_b$ (for KCl)

$\Delta T_b = K_b$ (for sugar)

$\therefore$ ΔT_b of 1 M KCl solution is double than that of 1 M sugar solution.

15. (a) On treating a precipitate of iron (III) oxide with a small amount of $FeCl_3$ solution, a reddish brown coloured colloidal solution is formed. In this case, Fe^{3+} ions from ferric chloride are adsorbed by $Fe(OH)_3$ precipitate.

$$\underset{\text{ppt.}}{Fe(OH)_3} + \underset{\text{Electrolyte}}{Fe^{3+}} \longrightarrow \underset{\text{Colloidal sol}}{Fe(OH)_3.\ Fe^{3+}}$$

(b) When dialysis is persistent and prolonged, the traces of electrolyte are also removed. These electrolytes stabilise the colloid and when removed completely, make the colloid unstable and the colloid gets coagulated.

(c) On centrifugation, emulsion is decomposed back into its constituent liquids. This process is called demulsification.

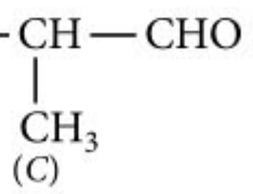
16. *Refer to answer 81, Page no. 119 (MTG CBSE Champion Chemistry)*

17. (a) As (*A*) and (*C*) given positive Tollen's test thus these two should be aldehyde white (*B*) should be a ketone (does not give Tollen's test) with —C(=O)—CH_3 group (as it gives positive iodoform test).

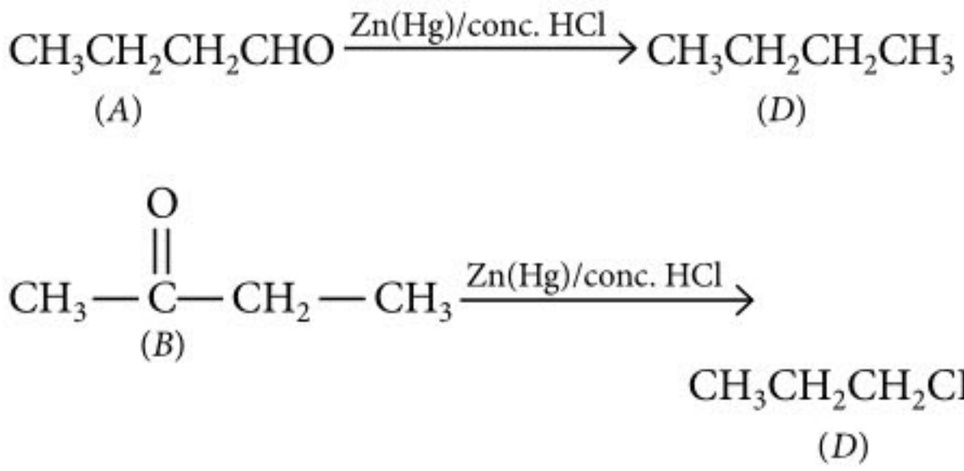
Three isomers are

$CH_3CH_2CH_2CHO$, (*A*)

CH_3—C(=O)—CH_2—CH_3, (*B*)



(*C*)



(b) Out of *A*, *B*, *C* isomers, *B* is least reactive towards addition of HCN.

18. (a) : Bithional added to soap to impart antiseptic properties and to reduce the odour produced by bacterial decomposition of organic matter on skin.

(b) 2-3% solution of iodine in alcohol-water mixture is known as tincture of iodine. It is a powerful antiseptic.

(c) Sodium benzoate acts as a food preservative.

19. (a) : $Fe_4[Fe(CN)_6]_3$

(b) *Refer to answer 40, Page no. 191 (MTG CBSE Champion Chemistry)*

(c) *Refer to answer 67 (i), Page no. 194 (MTG CBSE Champion Chemistry)*

20. (a) : *Refer to answer 32 (iii), Page no. 300 (MTG CBSE Champion Chemistry)*

(b) Denatured Protein : The protein obtained by the loss of biological activity by changing the pH, temperature or by adding some salt, due to disruption of the native structure is known as denatured protein *e.g.* coagulation of egg white on boiling.

(c) *Refer to answer 43, Page no. 301 (MTG CBSE Champion Chemistry)*

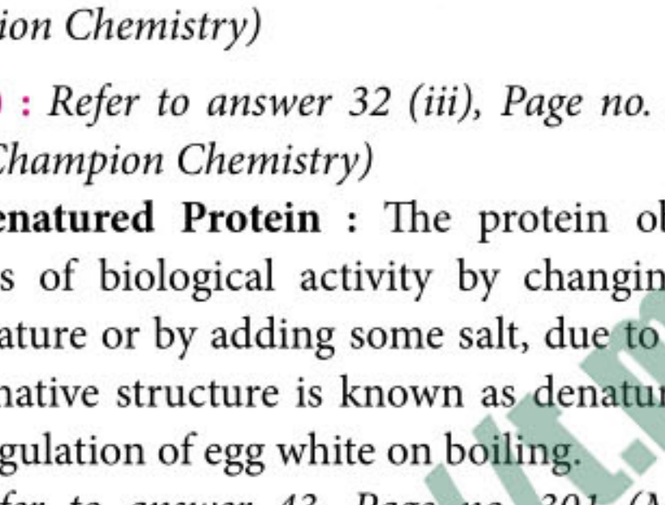
OR

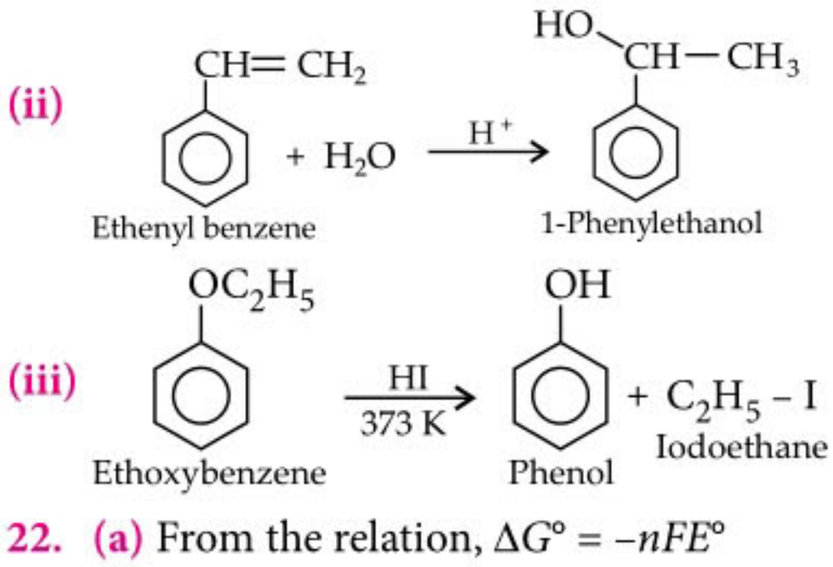
(a) *Refer to answer 14, Page no. 299 (MTG CBSE Champion Chemistry)*

(b) *Refer to answer 40, Page no. 301 (MTG CBSE Champion Chemistry)*

(c) In α-helix structure, intramolecular H-bonding takes place whereas in β-pleated structure intermolecular H-bonding takes place.

21. (i)





22. (a) From the relation, $\Delta G^\circ = -nFE^\circ$

More positive is the value of E°, reaction will be feasible.

$Mn^{3+} \xrightarrow{+e^-} Mn^{2+}$; $Fe^{3+} \longrightarrow Fe^{2+}$

$3d^4$ $3d^5$ more stable (half filled) $3d^5$ more stable (half filled) $3d^6$

Hence, E°_{value} for Mn^{3+}/Mn^{+2} couple is much more positive than that for Fe^{3+}/Fe^{2+}.

(b) Greater the number of unpaired electrons, stronger is the metallic bond and therefore, higher is the enthalpy of atomisation. Since, iron has greater number of unpaired electrons than copper hence has higher enthalpy of atomisation.

(c) *Refer to answer 55 (iii), Page no. 173 (MTG CBSE Champion Chemistry)*

23. (a) : Knowledge, tendency to spread awareness.

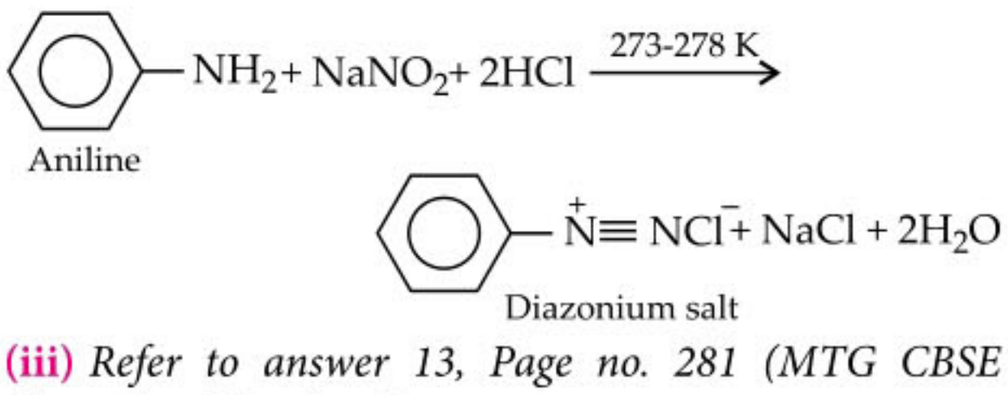
(b) The low density polythene has highly branched structure whereas high density polyethene has linear structure.

(c) Polythene bags are non-biodegradable hence, Shyam refused to accept the items in those bags.

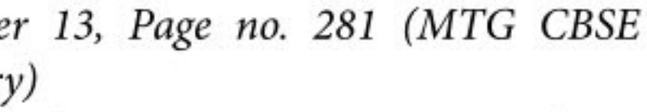
(d) *Refer to answer 69, Page no. 318 (MTG CBSE Champion Chemistry)*

24. (a) (i) *Refer to answer 11, Page no. 281 (MTG CBSE Champion Chemistry)*

(ii) Diazotisation :



Aniline



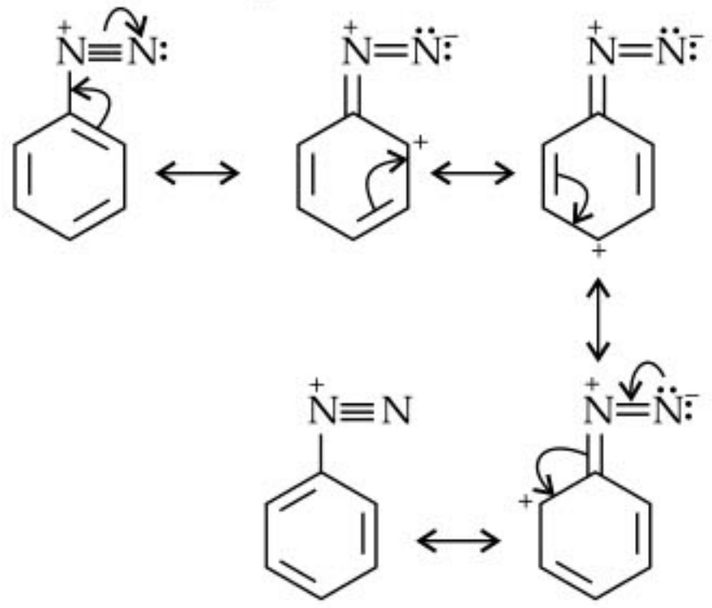
Diazonium salt

(iii) *Refer to answer 13, Page no. 281 (MTG CBSE Champion Chemistry)*

(b) (i) In aqueous solution, 2°-amine is more basic than 3°-amine due to the combination of inductive effect, solvation effect and steric reasons.

(ii) Diazonium salts carry a nitrogen atom with a positive charge. This positive charge is well dispersed in aromatic

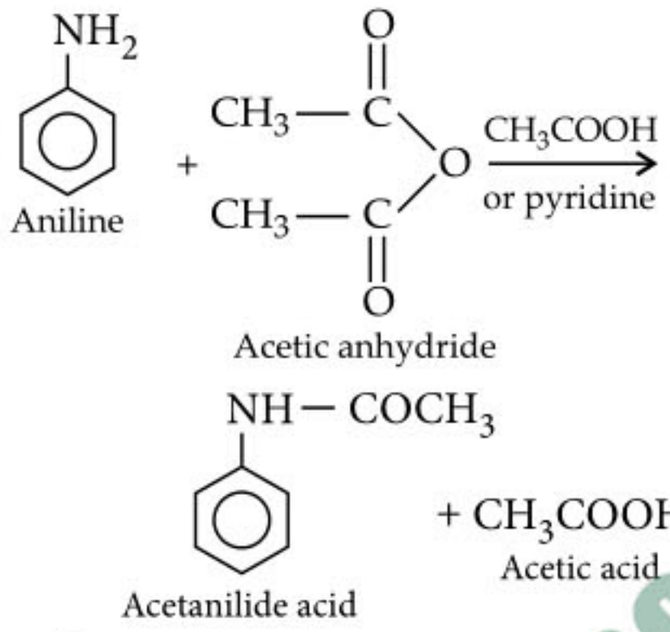
diazonium salts through resonance as shown below:



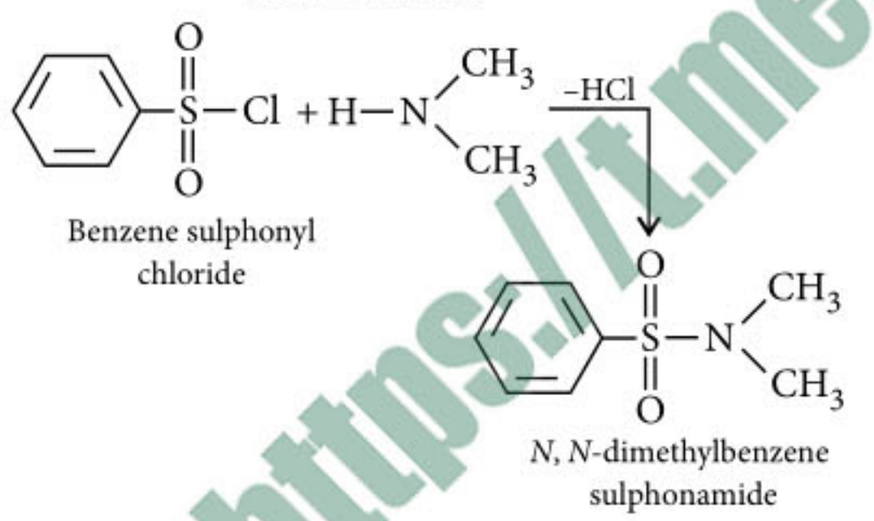
Such a charge delocalisation is not possible in aliphatic diazonium salts and hence they are less stable than aromatic diazonium salts.

OR

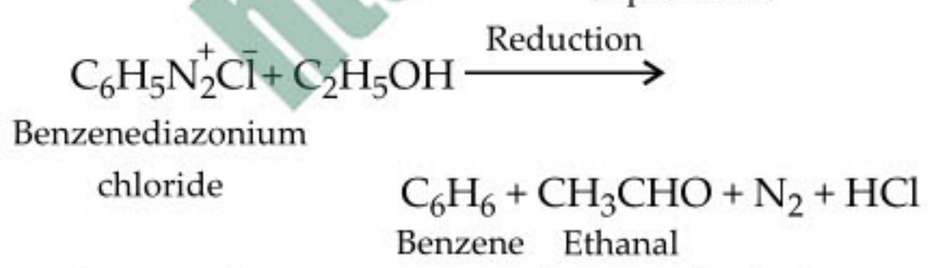
24. (a) (i)



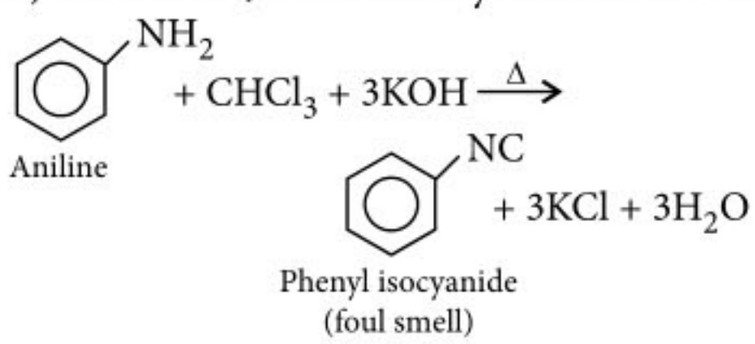
(ii)



(iii)



(b) Aniline undergoes isocyanide test (carbylamine reaction) whereas *N*, *N* – dimethylaniline does not.



(c) Stronger the base, lower will be the pK_b value.

$C_2H_5NH_2 < C_6H_5NHCH_3 < C_6H_5NH_2$

pK_b 3.29 4.63 9.38

25. (a) : (i) The oxoacid of phosphous containing +3 oxidation state, undergoes disproportionation to yield compounds in higher and lower oxidation states. Hence, H_3PO_3 undergoes disproportionation reaction but H_3PO_4 does not, as in it phosphorus is already in highest oxidation state (+5).

$$4\overset{+3}{H_3PO_3} \xrightarrow{\Delta} \overset{-3}{PH_3} + 3\overset{+5}{H_3PO_4}$$

(ii) Because of smaller size of F and bigger size of Cl, chlorine can accommodate three fluorine atoms around it but fluorine does not.

$$Cl_2 + \underset{\text{excess}}{3F_2} \xrightarrow{250°C} 2ClF_3$$

(iii) *Refer to answer 115, Page no. 148 (MTG CBSE Champion Chemistry)*

(b) : (i) *Refer to answer 245, Page no. 154 (MTG CBSE Champion Chemistry)*

(ii) *Refer to answer 218, Page no. 152 (MTG CBSE Champion Chemistry)*

OR

25. (a) (i) Light brown fumes of nitrogen dioxide are evolved on heating the nitrate with concentrated H_2SO_4.

$NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$4HNO_3 \rightarrow 2H_2O + 4NO_2 + O_2$

Brown fumes (*A*)

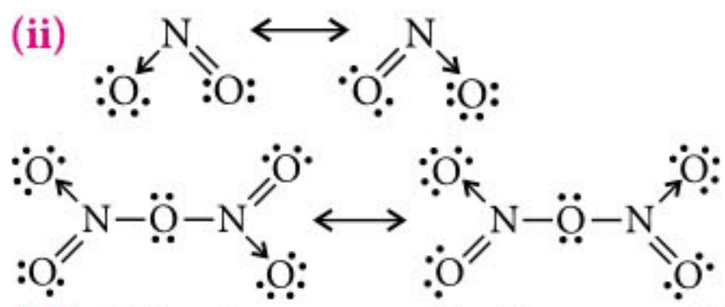
These fumes intensify when copper turnings are added.

$Cu + 4HNO_3 \rightarrow Cu(NO_3)_2 + 2NO_2 + 2H_2O$

On cooling NO_2 gas (*A*) converts to solid N_2O_4.

$$\underset{\text{Brown gas (A)}}{2NO_2} \underset{\text{heating}}{\overset{\text{cooling}}{\rightleftharpoons}} \underset{\text{Colourless solid (B)}}{N_2O_4}$$

(ii)



(iii) *Refer to answer 60, Page no. 146 (MTG CBSE Champion Chemistry)*

(b) The decreasing order of reducing character of the given hydrogen halides is HI > HBr > HCl > HF

(c) *Refer to answer 249, Page no. 154 (MTG CBSE Champion Chemistry)*

26. (a) The electrode reactions are

At anode : $Sn_{(s)} \rightarrow Sn^{2+}$ (0.004 M) + $2e^-$

At cathode : $2H^+$ (0.02 M) + $2e^- \rightarrow H_2$ (1 bar)

Net reaction :

$Sn_{(s)} + 2H^+$ (0.02 M) $\rightarrow Sn^{2+}$ (0.004 M) + H_2 (1 bar)

Scientist of the Month

August Wilhelm von Hofmann
(8 April 1818 - 5 May 1892)

Early Life and Education

August Wilhelm was a German chemist and he was born at Giessen, Grand Duchy of Hesse, on 8th April 1818. August Wilhelm matriculated at the University of Giessen in 1836.
He originally took up the study of law and philology at Giessen. August Wilhelm changed his studies to chemistry, and studied under Justus von Liebig. He obtained his PhD there in 1841.
In 1865, he returned to Germany to accept a position at the University of Berlin as a teacher and researcher. After his return, he co-founded the German Chemical Society (Deutsche Chemische Gesellschaft) (1867).

Contributions

Hofmann's work covered a wide range of organic chemistry. Hofmann was a major contributor to the development of techniques for organic synthesis, which originated at Liebig's laboratory in Giessen. Hofmann and John Blyth were the first to use the term "synthesis", in their paper.
A subsequent paper, Muspratt and Hofmann's "On Toluidine", described some of the first "synthetical experiments" (synthetische Versuche) in the field of organic chemistry. The ultimate goal of such experiments was to artificially produce naturally occurring substances, such a goal was not practically attainable at the time.
Hofmann also was the first to introduce molecular models into public lectures, around 1860 following the earlier (1855) suggestion by his colleague William Odling that carbon is tetravalent. Hofmann's colour scheme is still in use by some scientists :
carbon = black, hydrogen = white, nitrogen = blue, oxygen = red, chlorine = green, and sulphur = yellow.
He also invented the Hofmann voltmeter which is an apparatus used for electrolysing water.

Awards & Honours

- He was elected a fellow of the Royal Society in 1851. He was awarded the society's Royal Medal in 1854 and their Copley Medal in 1875.
- In 1900, the German Chemical Society built the "Hofmann-Haus" at Berlin and in 1902 created the August Wilhelm von Hofmann Gold Medal in his honour, to be awarded for outstanding achievements in chemistry.

☺☺

The Nernst equation of this cell at 25 °C

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{2}\log\frac{[Sn^{2+}](p_{H_2})}{[H^+]^2}$$

$$E^{\circ}_{cell} = E^{\circ}_{H^+|H_2} - E^{\circ}_{Sn^{2+}|Sn}$$

$= 0.000\ V - (-0.14\ V) = +0.14\ V$

or, $E_{cell} = E^{\circ}_{cell} - 0.0296\log\frac{0.004\times1}{(0.02)^2}$

$= E^{\circ}_{cell} - 0.0296\log\left(\frac{0.004}{0.0004}\right)$

$= E^{\circ}_{cell} - 0.0296\ (\log 10) = E^{\circ}_{cell} - 0.0296\times1$

$= E^{\circ}_{cell} - 0.0296 \Rightarrow E_{cell} = 0.14 - 0.0296 = 0.1104\ V$

(b) (i) The reaction at anode with lower value of E° is preferred *i.e.*, O_2 gas should be liberated but on account of overpotential of oxygen reaction at anode, preferred reaction is $Cl^-_{(eq)} \rightarrow \frac{1}{2}Cl_{2(g)} + e^-$ *i.e.*, Cl_2 gas is liberated at anode in the electrolysis of aq. NaCl.

(ii) Conductivity of CH_3COOH (weak electrolyte) decreases with dilution because the number of current carrying particles *i.e.*, ions present per cm^3 of the solution becomes less and less on dilution.

OR

26. (a) $\Delta G^{\circ} = -nFE^{\circ}_{cell}$

$$E^{\circ}_{cell} = \frac{\Delta G^{\circ}}{-nF} = \frac{-43600}{-2\times96500} = 0.226\ V$$

$2AgCl_{(s)} + H_{2(g)}\ (1\ atm) \longrightarrow 2Ag_{(s)} + 2H^+(0.1\ M) + 2Cl^-(0.1\ M)$

$$E_{cell} = E^{\circ}_{cell} - \frac{0.0591}{n}\log\frac{[Product]}{[Reactant]}$$

$$= 0.226 - \frac{0.0591}{2}\log\frac{(0.1)^2}{(1)}$$

$$= 0.226 - \frac{0.0591}{2}\log(10^{-2}) = 0.226 - \frac{0.0591}{2}(-2)$$

$= 0.226 + 0.0591 = 0.2851\ V$

(b) *Refer to answer 113 and 115 Page no. 66 (MTG CBSE Champion Chemistry)*

◈◈

CREATING LEADERS OF TOMORROW

International and National Rankings

THE WORLD UNIVERSITY RANKINGS 2018	18th joint rank among 42 institutions within India (801-1000th among 1102 institutions worldwide)	THE ASIA UNIVERSITY RANKINGS 2018	29th rank among 42 Universities in India (251-300th rank among Asian Universities)
QS UNIVERSITY RANKINGS ASIA 2018	210th rank among 400 institutions from 17 countries	nirf 2017	26th rank in 'Indian Engineering Institutions' category and 46th rank in 'University' category
INDIA TODAY INDIA'S BEST COLLEGES 2017 2017	10th among Best Engineering Colleges	CSR-GHRDC Engineering College Survey 2017	2nd rank among Top Engineering Colleges of Super Excellence
CAREERS 360 A Career is a Life	• 8th rank in Technology & Science • 52nd rank in Research • 2nd rank among (Private) Engineering Institutions	BRICS Rankings	137th rank

Accreditations: • NAAC (A Grade) for the period 2016-2021 • ABET (Accreditation Board for Engineering and Technology) of three UG programs in Mechanical, Civil and Electronics Engineering
• NBA accredited UG programs

• Credit transfer International Engineering Program (2+2) - Trinity College Dublin, University of New South Wales, Australia

2018-19 Admission Open

a) BE, B.Tech (Bio-Technology), BE-MBA, BE (LEET), MBA, ME, M.Tech, MCA, MSc, MA, PG Diploma (Professional)- Clinical & Counselling Psychology, PhD

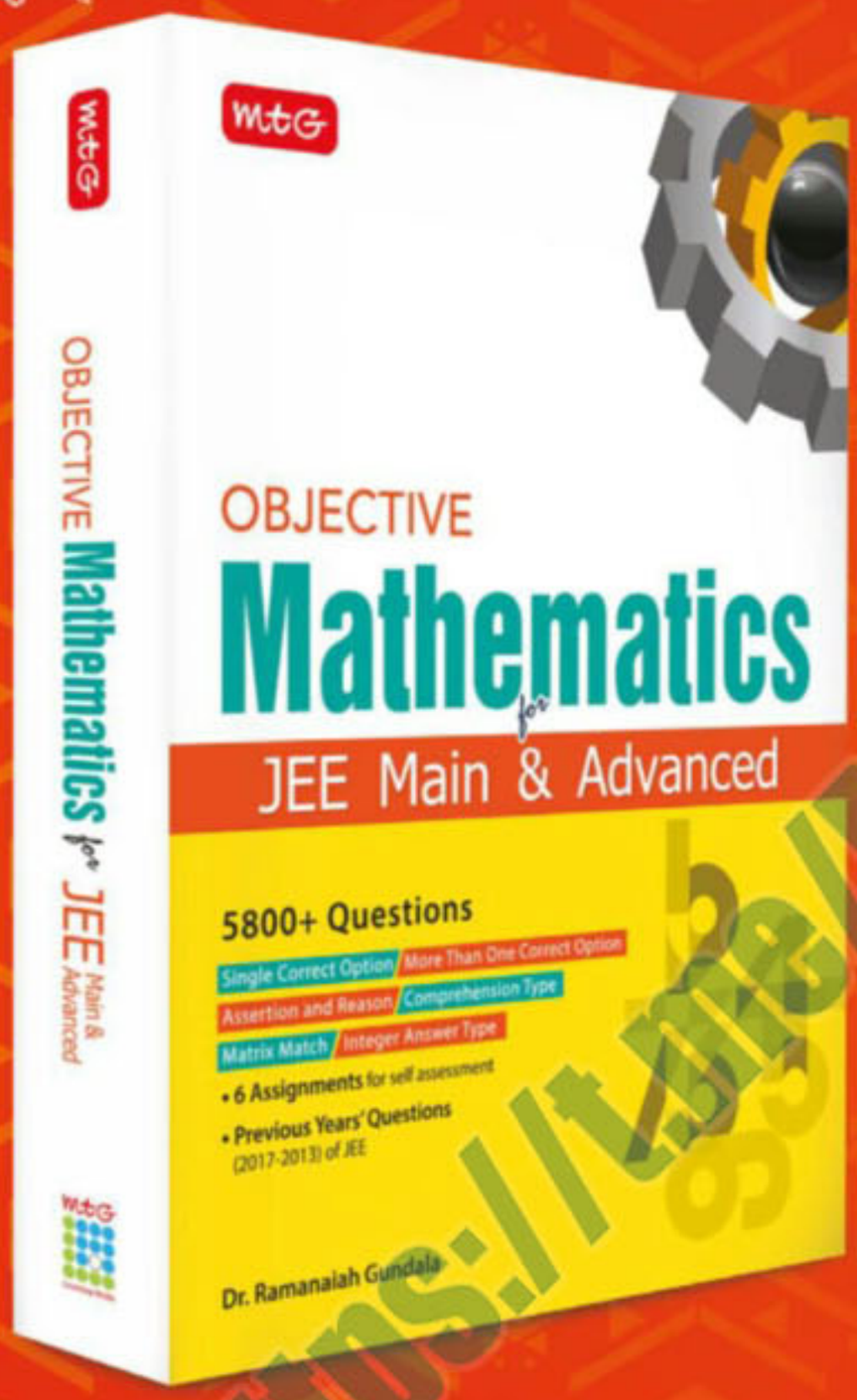
b) UG Admission criteria:
- BE, BE-MBA on JEE Main-2018 score.
- B.Tech (Bio-Technology) on NEET-2018 score.
- Direct admission & tuition fee waiver in BE, B.Tech for 5 toppers from recognized Secondary Boards
- Scholarships worth ₹12 Crores
- 1 seat per discipline for J&K & NE students

Application submission dates

BE, BE-MBA – April 29 | B.Tech (Bio-Technology) – July 13 | BE (LEET) – June 15 | MBA – June 15 | ME, M.Tech – June 30 | MCA – June 30 | MSc – June 30 | MA – June 30 | PG Diploma (Professional) – June 30 | PhD – June 30

Thapar Institute of Engineering & Technology | www.thapar.edu
P.O. Box 32, Bhadson Road, Patiala, Pin -147004 | Email ID : admissions@thapar.edu
Tel.: 8288008120, 8288008121, 6239397843, 6239398225.

ABRACADABRA



More than magic words, you need help from a magician to pass JEE with flying colours. Which is why MTG has collaborated with Dr Ramanaiah Gundala, the popular Maths professor from Chennai, to bring you the all-new Objective Mathematics for JEE Main & Advanced.

Includes
6 assignments for self-assessment
Previous years' JEE questions (2017-13)

Introductory price
₹ 750/-

Dr Ramanaiah Gundala

After securing his DIIT and Ph.D from IIT Kharagpur, Dr Gundala was elected Fellow of National Academy of Sciences (FNASc). His 50+ years of teaching experience includes distinguished tenures at IIT Kharagpur and Anna University, Chennai. He has authored 7 books and published an astonishing 85 research papers. He's now retired and prepares students for success in IIT-JEE at two leading coaching institutes in Chennai and Warangal.

Highlights of MTG's Objective Mathematics for JEE Main & Advanced

- Well-structured theory covering summary of important concepts and easy-to-understand illustrations
- 5800+ questions
- Unique and brain-stimulating exercises including questions of the following types:
  - Single Correct Option · More Than One Correct Option
  - Assertion and Reason. Comprehension Type
  - Matrix Match · Integer Answer Type

Visit **www.MTG.in** to buy online or visit a leading bookseller near you.
For more information, e-mail *info@mtg.in* or call **1800 300 23355** (toll-free) today.

MtG **TRUST OF MILLIONS, SINCE 1982**

Registered R.N.I. No. 53544/1991 *Published on 1st of every month* Postal Regd. No. DL-SW-01/4044/18-20
Lic. No. U(SW)-28/2018-20 to post without prepayment of postage N.D.P.S.O.N.D-1 on 2-3rd same month

30th Year
1988-2018
EXCELLENCE IN EDUCATION

Experience a Real Exam Scenario

Take the Mock Test for **AIIMS 2018** Computer Based Test (CBT)

Test Date: 14th May, 2018 (Monday) & 20th May, 2018 (Sunday)

Last Date for Enrollment: **10th May, 2018**

Time Slot:
Morning: 9:00 am to 12:30 pm
Evening: 2:00 pm to 05:30 pm

Eligibility:
Class 12 appeared / passed Students

Fee:
For New Student ₹ 500/-
For Aakashians **FREE**

Syllabus:
Complete Syllabus

Centres:
Across India*

Test Pattern of AIIMS 2018: Total 200 Questions (**PCB:** 120 MCQs + 60 AR type + **GK & Aptitude:** 20 MCQs)

Physics-60 | Chemistry-60 | Biology-60 | General Knowledge-10 | Aptitude & Logical Thinking-10

Salient Features: • Simulation of Actual Exam • Know your weak areas • All India Ranking & Analysis • Comprehensive Assessment • Get rid of Exam Fear • Understand Time Management • Enhance your chances of selection • Immediate Access to Answer Key & Solutions after exam • Test Papers prepared by experts & in sync with that of AIIMS • Video Solutions available on next day of Mock Test

Aakash
Medical | IIT-JEE | Foundations
(Divisions of Aakash Educational Services Pvt. Ltd.)

*Check with your nearest Aakash Centre

Apply @ **www.aakash.ac.in** | TOLL-FREE No. **1800-180-2727, 1800-102-2727**

Registered Office: Aakash Tower, 8, Pusa Road, New Delhi-110005. **Ph.:** (011) 47623456